Proceedings

AAVP

American Association of Veterinary Parasitologists

37th Annual Meeting

August 2-4
1992

Boston, Massachusetts
American Association of Veterinary Parasitologists
Founded 1956
Affiliated with the American Veterinary Medical Association

Officers 1991 - 1992

President: J. Owen D. Slocombe
University of Guelph
Guelph, ON N1G 2W1

President Elect: R. Fayer
USDA, ARS, LPSI
Beltsville, MD 20705-2350

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Kalamazoo, MI 49001

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McGill University
Montreal, PQ H9X 1C0

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Oklahoma State University
Stillwater, OK 74078

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Urbana, IL 61801

Constitution/Bylaws: Raymond E. Plue
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Athens, GA 30604

Education: Byron L. Blagburn
Auburn University
Auburn, AL 36849

Finance: Dennis D. French
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Baton Rouge, LA 70803-6002

Newsletter: H. Ray Gamble
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Beltsville, MD 20705-2350

Nominations: C. Ed Couvillion
Mississippi State University
Mississippi State, MS 39762

Outreach/Research: Alan A. Marchiondo
Fermenta Animal Health Co.
Kansas City, MO 64153-2314

Program: George A. Conder
Upjohn Laboratories
Kalamazoo, MI 49001

Publications: Charles H. Courtney
University of Florida
Gainesville, FL 32610

Historian: R.A. Roncalli
Merck & Company
Rahway, NJ 07065
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
1988-1989  H.C. Gibbs
1989-1990  B.E. Stromberg
Winners - AAVP Awards

Distinguished Veterinary Parasitologist

<table>
<thead>
<tr>
<th>Year</th>
<th>Winner</th>
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<tbody>
<tr>
<td>1985</td>
<td>J.P. Dubey</td>
</tr>
<tr>
<td>1986</td>
<td>N.D. Levine</td>
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<td>1987</td>
<td>E.J.L. Soulsby</td>
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<td>1988</td>
<td>J.F. Williams</td>
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<td>1989</td>
<td>K.D. Murrell</td>
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<tr>
<td>1990</td>
<td>W.C. Campbell</td>
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<tr>
<td>1991</td>
<td>J.H. Drudge &amp; E.T. Lyons</td>
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Hoechst-Roussel Agri-Vet Company

Graduate Student Research Award

<table>
<thead>
<tr>
<th>Year</th>
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<tbody>
<tr>
<td>1987</td>
<td>L.G. Rickard</td>
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<tr>
<td>1988</td>
<td>D.A. Cross</td>
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<tr>
<td>1989</td>
<td>S.C. Barr</td>
</tr>
<tr>
<td>1990</td>
<td>J.C. Parsons</td>
</tr>
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<td>1991</td>
<td>C.E. Lanusse</td>
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Distinguished Service

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<th>Year</th>
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<tr>
<td>1976</td>
<td>R.R. Bell</td>
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<tr>
<td>1987</td>
<td>N.F. Baker</td>
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<td>1988</td>
<td>D.E. Cooperrider</td>
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SPONSORS-- 37th Annual Meeting

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*Provided Echinococcus Fellowship.
**Provided honorarium for Graduate Student Award.
***Provided honorarium for the Distinguished Veterinary Parasitologist Award.
****Provided support for the President’s Symposium.

The American Association of Veterinary Parasitologists gratefully acknowledges the above Corporations for their loyal support and sponsoring of special sectors of the 1992 AAVP Conference.
Registration - 37th Annual Meeting
The Westin-Copley Place, Boston, Massachusetts
Foyer America South Room
Sunday  8:00 AM

Social Program

Saturday, August 1, 1992
The Westin-Copley Place, Staffordshire Room
Pre-Meeting Mixer
7:00 - 10:00 PM

Sunday, August 2, 1992
The Westin-Copley Place, Essex South Room
Hoechst-Roussel Agri-Vet Co. Sponsored Social
6:00 - 7:30 PM

Monday, August 3, 1992
The Westin-Copley Place, Essex South Room
Miles Inc. Sponsored Social
7:00 - 8:30 PM

Speaker Ready Room
The Westin-Copley Place
Bauer Audio Video Speaker Ready Room

AAVP Spouse Meeting Room
Sunday & Monday, August 2-3, 1992
The Westin-Copley Place, Daniel Webster Room
8:00 AM - 5:00 PM
## SCIENTIFIC PROGRAM OVERVIEW
### 37TH ANNUAL MEETING
### AAVP BOSTON, MASSACHUSETTS

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<thead>
<tr>
<th>August 2, Sunday</th>
<th>America South Room SESSION A</th>
<th>America Center Room SESSION B</th>
<th>America North Room SESSION C</th>
<th>August 3, Monday</th>
<th>America South Room SESSION D</th>
<th>America Center Room SESSION E</th>
<th>America North Room SESSION F</th>
<th>August 4, Tuesday</th>
<th>Room 102 SESSION G</th>
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<tbody>
<tr>
<td>8:00 AM</td>
<td>Registration (Foyer America South Room)</td>
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<td>8:00 AM</td>
<td>Invited Presentations: Zoonoses</td>
<td></td>
<td></td>
<td>9:30 AM</td>
<td>President's Symposium AAVP/AVMACosponsored: Resistance to Parasiticides</td>
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<tr>
<td>8:30</td>
<td>Opening Remarks</td>
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<td></td>
<td>9:30</td>
<td>Coffee (Sponsored by Pfizer)</td>
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<tr>
<td>9:00</td>
<td>Invited Presentations: Neurobiology/Neuropharmacology of Helminths and Ectoparasites</td>
<td>10:45 AM Host Recognition/Parasite Development</td>
<td>10:45 AM Diagnosis/Molecular Biology</td>
<td>9:45</td>
<td>Clinical Reports/Surveys</td>
<td>9:45 AM Chemotherapy 3</td>
<td>9:45 AM Models/Parasite Culture</td>
<td>11:20</td>
<td>President's Symposium (Continued)</td>
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<td>10:30</td>
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<td>11:45</td>
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<td>12:00</td>
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<td>10:45</td>
<td>Chemotherapy 1</td>
<td>10:45 AM Host Recognition/Parasite Development</td>
<td>10:45 AM Diagnosis/Molecular Biology</td>
<td>12:00 Lunch</td>
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<td>12:00</td>
<td>Lunch</td>
<td>12:00 Lunch</td>
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<td>1:15 PM</td>
<td>Presidential Address</td>
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<td>1:00 PM</td>
<td>Business Meeting</td>
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<td>1:30</td>
<td>Awards</td>
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<td>2:15</td>
<td>Special Presentation: Towards a Better Meeting: The Visual Presentation of Parasitological Graphs and Tables</td>
<td>2:15 PM Chemotherapy 4</td>
<td>2:15 PM Molecular Biology</td>
<td>2:15 PM</td>
<td>Chemotherapy 5</td>
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<td>2:15</td>
<td>Clinical Reports</td>
<td>2:15 PM Chemotherapy 2</td>
<td>2:15 PM Vaccines</td>
<td>2:15</td>
<td>Chemotherapy 4</td>
<td>2:15 PM Chemotherapy 5</td>
<td>2:15 PM Molecular Biology</td>
<td>3:00 PM</td>
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<td>3:45</td>
<td>Clinical Reports (Continued)</td>
<td>3:45 Chemotherapy 2 (Continued)</td>
<td>3:45 Vaccines (Continued)</td>
<td>4:00</td>
<td>Pathology</td>
<td>4:00 Chemotherapy 6</td>
<td>4:00 Aquaculture/Performance/Genetics</td>
<td>5:00</td>
<td>Mini-Symposium: Echinococcosis (Sponsored by Miles Inc.)</td>
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<td>4:30</td>
<td>Mini-Symposium: Strategic Parasite Control (Sponsored by Hoechst-Roussel Agri-Vet Co.)</td>
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<td>7:00</td>
<td>Social* (Sponsored by Miles Inc.)</td>
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<td>9:00</td>
<td>Models of Snail Borne Disease</td>
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<tr>
<td>6:00</td>
<td>Social* (Sponsored by Hoechst-Roussel Agri-Vet Co.)</td>
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<td>9:00</td>
<td>Epidemiology/Resistance</td>
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<td>9:00</td>
<td>Models of Snail Borne Disease</td>
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* Essex South Room
AMERICAN ASSOCIATION OF VETERINARY PARASITOLOGISTS
Program 37th Annual Meeting
Boston, Massachusetts

Saturday, August 1, 1992
The Westin-Copley Place,
Staffordshire Room

7:30 PM  AAVP Pre-meeting Mixer

Sunday, August 2, 1992
The Westin-Copley Place,
America South Room

8:00 AM  Registration

8:30  Opening Remarks:
President Owen Slocombe
Vice-President and Program
Chairman George Conder

Session A1 - Neurobiology/
Neuropharmacology of
Helminths and Ectoparasites.
Moderator: J.F. Williams

9:00 Invited Presentation
1. The biological basis of
nematode neuropharmacology.
  T.G. Geary*, J.W. Bowman,
  R.D. Klein, L. Vanover, and
  D.P. Thompson

9:30 Invited Presentation
2. The neurobiology of flatworms:
   How can an animal function
   without a brain.
   J.L. Bennett*, R.A. Pax,
   and T. Day

9:45 Coffee

10:00 Invited Presentation
3. The neurobiology/
   neuropharmacology of
   ectoparasites.
   J.R. Sauer*

10:30 Coffee

10:45 4. Results of clinical trials in cats
   and dogs, using lufenuron, an
   insect development inhibitor.
   S.C. Parks*

11:00 5. Efficacy of lufenuron, a
   benzoylphenyl urea, for control of
   pre-adult stages of
   Ctenocephalides felis on cats.
   B.L. Blagburn*, C.M.
   Hendrix, J.L. Vaughan, D.S.
   Lindsay, and S. Barnett

11:15 6. Safety evaluation of lufenuron
   in dogs and cats.
   W.R. Campbell*

11:30 7. Efficacy and safety of
   fenoxycarb pet spray for control of
   Ctenocephalides felis infestations
   on dogs and cats.
   A.A. Marchiondo*, S. Ackers,
   S.W. Fagt, D.L. Heimbichner,
   and R. Young

11:45 8. Insecticide ear tags - past,
   present and future.
   J.L. Riner*

12:00 Lunch

11:00 10. Processes which regulate and control the free-living and parasite stages of Haemonchus contortus. M.J. Coyne* and G. Smith


12:00 Lunch
1:15 PM  Presidential Address: Owen Slocombe
         Moderator: R. Fayer

1:30 Awards
         Awards Chairman: J.A. DiPietro

The Westin-Copley Place,
America South Room
Session A3 (Concurrent) - Clinical Reports
Moderators: F.L. Andersen and C.H. Courtney

      J.P. Dubey*, H.M. Acland, and A.N. Hamir

2:30 20. Occurrence of clinical lungworm infection (Protostrongylus rufescens) in a sheep flock in Maryland.
      L.S. Mansfield* and H.R. Gamble

      G.H. Myers*, E.A. Keith, D.H. Bliss, J.E. Miller, and I. Hagsten

3:00 22. Are there any clinical cases of bovine gastrointestinal nematodiasis in Arizona?
      R.C. Bergstrom* and E. Bicknell

3:15 23. Severe flea infestation in dairy calves.
      M.W. Dryden* and A.B. Broce

3:30 Coffee

      G. Charbonneau*, C. Piché, A. Villeneuve, P. Bahnson, and R. Garcia

4:00 25. Isolation and characterization of Sarcocystis neurona from a native Panamanian horse.
      D.E. Granstrom*, O. Alvarez, Jr., J.P. Dubey, P.F. Comer, and N.M. Williams

4:15 26. Local lymphoid changes after Ostertagia ostertagi infection in naive and previously immunized calves.
      L.C. Gasbarre* and A. Canals

2:15 PM 27. The effect of moxidectin on bovine gastrointestinal nematodes.
         D.K. Miller*, T.M. Craig, and G.T. Wang

2:30 28. Dose titration of moxidectin 1% injectable against ruminant helminths.
       G.T. Wang* and D. Rock

2:45 29. Efficacy of Cydectin® moxidectin 1% injectable against gastrointestinal nematode and lungworm infections in calves.
       J.C. Williams*, C. Nault, and R.T. Ramsey
3:00  30. Efficacy of injectable moxidectin at two dose rates against natural gastrointestinal nematode infections of beef cattle.
   J.A. Stuedemann*, H. Ciordia, G.T. Wang, and J. Huang

3:15  31. Dose titration of moxidectin pour-on in cattle infected with gastrointestinal nematodes.
   C.E. Couvillion* and F. Guerino

3:30  Coffee

3:45  32. Efficacy of moxidectin pour-on in calves.

4:00  33. Moxidectin: systemic activity against common cattle grubs (Hypoderma lineatum) (Diptera: Oestridae) and trichostrongyle nematodes in cattle.
   P.J. Scholl* and G.T. Wang

The Westin-Copley Place,
America North Room
Session C2 (Concurrent) - Vaccines
Moderators: B. Hammerberg and P.M. Schantz

2:15 PM  34. Vaccination of weaned pigs with a temperature sensitive mutant of Toxoplasma gondii.
   D.S. Lindsay*, B.L. Blagburn, and J.P. Dubey

2:30  35. Identifying protective developmental stage and associated antigens of coccidial parasites using gamma irradiation.
   M.C. Jenkins*, P.G. Seferian, R.A. Clare, F.C. Augustine, and H.D. Danforth

2:45  36. Babesia divergens culture-derived exoantigens used as vaccine.
   A. Gorenflot*, E. Précigout, A. Valentin, G. Bissuel, B. Carcy, P. Brasseur, Y. Moreau, and J. Schrével

3:00  37. A phylogenetically conserved gut surface antigen(s) of Haemonchus contortus and its efficacy in inducing protective immunity.
   D.P. Jasmer*, L.E. Perryman, S.L. Crow, G.A. Conder, and T.C. McGuire

3:15  38. Involvement of brain in Plasmodium knowlesi Rhesus monkey model: Immune protection studies.
   A.A. Mahdi* and R.K. Singh

3:45  Coffee

4:00 40. Vaccination of ponies with Strongylus vulgaris irradiated larvae, adult worm somatic antigens, or larval somatic antigens plus excretory/secretory products.

4:15 41. Further characterization of the Heligmosomoides polygyrus L4 subcutaneous (S.C.) vaccine.
   L.H. Semprevivo*, M.D. Maloney, and J.P. Tritschler II

4:30 42. HRAVC and veterinary parasitology - an overview.
   A.R. Donoghue*

4:50 43. Review of Nematodirus helvetianus.
   D.H. Bliss*

5:10 44. Designing, implementing and monitoring strategic parasite control programs.
   G.H. Myers*

6:00 Sponsored Social
   Hoechst-Roussel Agri-Vet Co.
   The Westin-Copley Place,
   Essex South Room

The Westin-Copley Place,
America South Room
Session A4 - Strategic Parasite Control Mini-Symposium
(Sponsored by Hoechst-Roussel Agri-Vet Co.)
Moderator: G.H. Myers

9:00 PM 45. Serum from dogs infected with Dirofilaria immitis depresses endothelium-dependent relaxation of the in vitro rat aorta.
   V.L. Lamb*, J.F. Williams, and L. Kaiser

9:15 46. Ivermectin paralyses the pharynx of Haemonchus contortus.

9:30 47. Organic acid excretion by Haemonchus contortus: implications for cuticle microenvironmental pH regulation and drug absorption.


The Westin-Copley Place,
America Center Room
Session B3 (Concurrent)- Models of Snail Borne Disease
Moderators: B.E. Stromberg and A.M. Zajac
9:00 PM 49. Satellite climatology and patterns of snail borne disease in Egypt.
J.B. Malone*, P.A. Wilson, D.P. Fehler, O.K. Huh, and A. Elmagdoub

9:15 50. Development of a growing degree day model of minimum time from infection of snails to cercarial production for Schistosoma haematobium in Bulinus truncatus and Schistosoma mansoni in Biomphalaria glabrata.
S.H. Zukowski* and J.B. Malone

9:30 51. Experimental infection of three lymnaeid snail species with Fascioloides magna.
J.R. Laursen*, G.A. Averbeck, G.A. Conboy, and B.E. Stromberg

Monday, August 3, 1992
The Westin-Copley Place,
America South Room
Session D1 - Zoonoses
Moderator: J.R. Lichtenfels
8:00 AM Invited Presentation
56. An update on the etiology of zoonotic visceral and ocular larva migrans.
K.R. Kazacos*

8:30 Invited Presentation
57. The zoonotic aspects of giardiasis.
G.M. Faubert*

9:00 Invited Presentation
58. Studies in Brazil to determine if the dog is an important animal reservoir for human visceral leishmaniasis.
J.R. David*, D.A. Ashford, C. Eulalia, M. Freire, C. Miranda, M.G. Zalis, and R. Badaró

9:00 PM 52. A revised taxonomy for Trichinella and its relevance to the epidemiology of trichinellosis.
E. Pozio, G. La Rosa, K.D. Murrell*, and J.R. Lichtenfels

9:15 53. Epidemiology of parasitic gastroenteritis of sheep on St. Croix.
C.H. Courtney* and S. Wildeus

G. Zhu* and L.R. McDougald

9:45 55. Flow cytometric analysis of ionophore resistant and sensitive sporozoites of Eimeria tenella after treatment with fluorescein diacetate and propidium iodide.
A.L. Fuller*, J. Golden, and L.R. McDougald

56. Characterization of ionophore resistance in a strain of E. tenella.
G. Zhu* and L.R. McDougald

55. Flow cytometric analysis of ionophore resistant and sensitive sporozoites of Eimeria tenella after treatment with fluorescein diacetate and propidium iodide.
A.L. Fuller*, J. Golden, and L.R. McDougald

The Westin-Copley Place,
America South Room
Session D2 (Concurrent) - Clinical Reports/Surveys
Moderators: B.L. Blagburn and K.S. Todd

9:30 Coffee (Sponsored by Pfizer)
9:45  59. Autochthonous canine leishmaniasis in Michigan.

10:00 60. Prevalence of endoparasitic infections in dogs and cats seen at the hospital of the University of Pennsylvania School of Veterinary Medicine from 1984 to 1991.
      T.J. Nolan* and G. Smith

10:15 61. Dirofilaria immitis in dogs in British Columbia, Canada: First recognized autochthonous case and a practitioner-based survey of testing and prevalence.
      L. Polley*, G. Mackenzie, B. Wagner, and P. Haugen

10:30 62. Heartworm in Minnesota - reflection of the past ten years.
      B.E. Stromberg*, S.M. Prouty, G.A. Averbeck, and J.C. Schlotthauer

10:45 63. A new species of Megatrypanum from a Russian pallas cat Felis manul also infected with Hepatozoon and feline immunodeficiency virus.
      S.C. Barr*, D.D. Bowman, and L. Phillips

11:00 64. Continued studies on cystic echinococcosis in the Xinjiang/Uygur Autonomous Region, PRC.
      F.L. Andersen*, R. Ming, H.D. Tolley, J. Chai, and F. Liu

11:15 65. Chandlerella quiscali, a parasite who's time has come or "Big Bird's nemesis".

11:30 66. Taxonomical research on helminths of non-aquatic birds.
      M.R. Siavashi* and J. Masoud

11:45 Lunch
10:30  70. Duration of efficacy for various anthelmintics used to control parasites in the young horse.
   J. Kivipelto* and R.L. Asquith

10:45  71. Efficacy of moxidectin against equine parasites.
   T.R. Bello*, J.E.T. Laningham, and R. Aguilar

11:00  72. Dose titration study of moxidectin gel as an oral equine anthelmintic.
   C.R. Reinemeyer* and R. Aguilar

11:15  73. Efficacy of moxidectin gel in equids.

11:30  74. Efficacy of moxidectin gel against internal parasites of ponies.

11:45  75. Efficacy of moxidectin against migrating larvae of Strongylus vulgaris and Parascaris equorum.

12:00 Lunch

   M.E. Doscher*

10:00  77. Paraban, a model for evaluating anthelmintic strategies against common trichostrongylid infections of cattle.
   G. Smith* and J. Guerrero

10:15  78. A gentleperson’s guide to practical fleakeeping.
   J.R. Georgi* and M.E. Georgi

10:30  79. A basic medium for the propagation of cyclopod copepods.
   P.A. Akpan*

10:45  80. Attempts at in vitro culture of Eperythrozoon suis.

11:00  81. Experimentally induced proliferative gill disease (PGD) in catfish after exposure to a myxozoan parasite.
   L.M. Pote*, T.L. Lin, E.F. Chenney, and J.A. Hackathorn

11:15  82. Experimental infection of dogs with Giardia.
   A.M. Zajac*, M.L. Leib, G. Saunders, N.E. Hahn, S. King, and M. Matz

11:30  83. Experimental bovine nematodiriasis: Studies on the response of calves to moderate to high levels of exposure.
   D.E. Worley, F.M. Seesee, and E.O. Dickinson*
11:45  Biochemical studies of GTP-binding proteins in Trypanosoma cruzi.

2:45  Efficacy of DEC/oxibendazole, ivermectin, ivermectin + pyrantel pamoate, and milbemycin oxime against roundworm and hookworm infections in dogs.
S.E. Marley*, M.L. Michalski, R. Corwin, and M. Van Schoyck

12:00  Lunch
The Westin-Copley Place, America South Room

1:00 PM  Business Meeting
President: Owen Slocombe

2:00  Special Presentation
84. Towards a better meeting: The visual presentation of parasitological graphs and tables.
J. Williams*, K. Kazacos, and G. Zimmerman

3:00  Efficacy of milbemycin oxime against Ancylostoma tubaeforme in experimentally infected cats.
B.L. Blagburn*, C.M. Hendrix, J.L. Vaughan, D.S. Lindsay, and D.I. Hepler

2:15  Safety and efficacy against experimental infections of heartworm and intestinal parasites of an ivermectin/pyrantel combination chewable.
J.N. Clark*

3:15  In vitro antifungal activity of naftifine against Microsporum canis.
P. Butty, M. Mallié, A. Gorenflo*t*, and J.M. Bastide

2:30  Field efficacy of an ivermectin/pyrantel combination chewable against ascarids and hookworms in dogs.

3:30  Hyperimmune bovine colostrum, a unique treatment for avian coccidiosis due to Eimeria acervulina.
R. Fayer* and M.C. Jenkins

2:15 PM  Patent infections of Ascaris suum in pigs: Effects of previous exposure to multiple, high levels of infection and anthelmintic treatment regimes.
M. Stankievicz, W. Jonas, and D.L. Froe II*

2:45 93. Efficacy evaluation studies on abamectin and morantel in cattle. T.A. Yazwinski* and H. Featherston


3:15 95. Comparison of treatment strategies with ivermectin (IVM) for control of gastrointestinal nematodes of cattle in Louisiana. J.C. Williams*

3:30 96. Effects of immature liver flukes on grazing stocker cattle and of adult liver flukes on feedlot cattle, and strategic deworming with ivermectin-F®. S.E. Marley*, D.P. Hutcheson, and R.M. Corwin

3:45 Coffee (Sponsored by Pfizer)

The Westin-Copley Place, America North Room
Session F2 (Concurrent) - Molecular Biology
Moderators: T.G. Geary and D.E. Hill

2:15 PM 97. The identification and characterization of a break within the large subunit ribosomal RNA of Trichinella spiralis: Comparison of gap sequences within the genus.
D.S. Zarlenaga* and J.B. Dame

2:30 98. Cloning and mapping of ribosomal RNA gene repeats within the genus Haemonchus; identification of PCR primers for rapid differentiation.
D.S. Zarlenaga*, F.S. Stringfellow, M. Nobary, and J.R. Lichtenfels


3:00 100. A cloned filarial antigen Di5, released from Dirofilaria immitis.
L.A. McReynolds*, Y. Hong, and C.B. Poole

G.R. Frank* and R.B. Grieve

3:30 102. A cDNA encoding an antigen present on Eimeria acervulina sporozoites and merozoites.
P.G. Seferian* and M.C. Jenkins

3:45 Coffee (Sponsored by Pfizer)
The Westin-Copley Place, America South Room
Session D4 (Concurrent) - Pathology
Moderators: J.P. Dubey and T.R. Klei

4:00 103. Lectin binding to eosinophil granules as a method of detecting eosinophil products in parasitized tissues.
C.D. Mackenzie*, C. Ayala, and D. Craft

4:15 104. Pathogenesis and immune changes during primary and secondary experimental infections of dogs with Brugia pahangi.
D. Schreuer and B. Hammerberg*

4:30 105. Pathophysiological changes in grouse and chickens infected with Trichostrongylus tenuis.
G.R. Wilson, C.D. Mackenzie*, and M. Worms

4:45 106. Excystation and development in vitro and in vivo of Eimeria tenella after irradiation of oocysts.
L.R. McDougald*, A.L. Fuller, J. Gilbert, and T. Scott

The Westin-Copley Place, America North Room
Session F3 (Concurrent) - Aquaculture/Performance/Genetics
Moderators: R.G. Arther and A.A. Marchiondo

4:00 PM 107. Paraherquamide-overview of efficacy and safety.

4:15 108. Daily evaluation of the suppression of nematode egg production in sheep by treatment with thiabendazole, levamisole or ivermectin.

4:30 109. In vitro and in vivo evaluation of selected β-ketoamides and dioxapyrrolomycin for cross-resistance with known anthelmintics.

4:45 110. Enhanced growth of alveolar hydatid cysts in praziquantel-treated jirds (Meriones unguiculatus).
R. Ming*, F.L. Andersen, A.A. Marchiondo, G.A. Conder, and J.H. Slusser
4:15 112. Parasite effects on animal performance - an animal science course.  
T.B. Stewart*, J.E. Miller, and T.R. Klei

4:30 113. Apparent digestibility coefficients in heavily parasitized and minimally parasitized pony yearlings.  

4:45 114. Nematode susceptibility and genetic variation in the MHC class II region between Dorper and Red Maasai sheep from Kenya.  
J.E. Miller*, N.E. Muggli-Cockett, and L.E. Reynolds

5:00 115. Echinococcus multilocularis: Overview of distribution and spread in the contiguous United States.  
K.R. Kazacos*

5:15 116. Prevalence, distribution and intensity of Echinococcus multilocularis infection in wild canids in Indiana and bordering states.  
S.T. Storandt* and K.R. Kazacos

5:30 117. Difficulties with the identification of Echinococcus multilocularis infections in dogs and cats.  
M.B. Hildreth*, D. Blunt, and S. Saileela

5:45 118. A survey to evaluate the potential introduction of Echinococcus multilocularis in fox-chasing enclosures in the Southeast.  
W.R. Davidson, G.W. Lee, and V.F. Nettles*

6:00 119. Incidence of Echinococcus in Morocco. Recent observations of a Peace Corp veterinarian and why practitioners in North America should be aware of this zoonotic disease.  
H.C. Lloyd*

6:15 120. Echinococcus multilocularis infection: An emerging public health problem. What can we do about it?  
P.M. Schantz*

7:00 Miles Inc. Sponsored Social  
The Westin-Copley Place, Essex South Room

Tuesday, August 4, 1992  
John B. Hynes Veteran's Memorial Convention Center, Room 102

9:30 AM Chairman's Opening Remarks
Anthelmintic Resistance

9:35  121. Mechanisms of resistance of nematodes to anthelmintics.
      G.A. Conder*

10:00 122. Strongyles in horses - control of anthelmintic resistance.
       T.R. Klei*

10:25 123. Trichostrongyles in sheep and goats - control of anthelmintic resistance.
       R.M. Corwin*

10:50 Coffee

Insecticide Resistance

        R.L. Byford* and B.L. Crosby

11:45 125. Horn flies on cattle - control of insecticide resistance.
        J.L. Riner*

12:10 126. Fleas on dogs and cats - control of insecticide resistance.
        M.W. Dryden*

12:35 Summary
        O. Slocombe
1
THE BIOLOGICAL BASIS OF NEMATODE NEUROPHARMACOLOGY.
THE UPJOHN COMPANY, UPJOHN LABORATORIES, KALAMAZOO, MI 49001.

The neuromuscular systems of nematodes are anatomically, physiologically and pharmacologically distinct from those of their vertebrate hosts. Drugs such as levamisole and piperazine are known to exploit host-parasite differences in receptor pharmacology, leading to selective paralysis and expulsion of the worms. Although these drugs illustrate the promise of chemotherapy targeted at the nematode neuromusculature, no novel compounds with this site of action have been discovered in the past 15 years. The precise mechanism of action of the most recent neuroactive compounds, the avermectin/milbemycin class, is still unresolved.

The difficulty of discovering new selective nematode neuromuscular drugs is due at least in part to our shallow understanding of the biochemical and molecular differences which underlie host-parasite differences in neurobiology. Important neurotransmitter and neuropeptide functions remain to be described, and nothing is known in any detail about receptors or ion channels in parasitic nematodes.

The development of detailed information about mammalian receptors and ion channels has led to an explosion of novel compounds, discovered through mechanism-based assays. Similar benefits in nematode control can be anticipated as basic research in parasite neurobiology progresses to this level.

2
THE NEUROBIOLOGY OF FLATWORMS: HOW CAN AN ANIMAL FUNCTION WITHOUT A BRAIN. J. L. BENNETT*, R.A. PAX AND T. DAY. MICHIGAN STATE UNIVERSITY, EAST LANSING, MICHIGAN 48840

The flatworm nervous system remains a prime target for developing drugs against these parasites but our understanding of how this system functions to regulate various physiological processes of the flatworm is very undeveloped. About all we can say is that a number of pharmacological agents, initially characterized on mammalian preparations, can affect the motor activity of intact flatworms. Unlike the nematode's nervous system, the nervous system of parasitic flatworms cannot be isolated anatomically. This severely limits our ability to perform classical electrophysiological experiments that would allow us analyze the physiological impact of a given neuron to a particular organ system of the parasite. To overcome this problem we first developed techniques for the isolation of single cells from various parasite organ systems. The prime objective of this work is to begin a systematic characterization of the nature of the pharmacological receptors on important organ systems of the flatworm. We have characterized 3 morphologically distinct muscle cells from a flatworm and have analyzed the response of these muscle cells to various pharmacological agents. In addition we have utilized the method of patch clamp analysis to characterize the ion channels on these cells in both the patch configuration, whole cell configuration and most recently the perforated patch configuration. Our presentation will focus on the results we have obtained utilizing these techniques and the pitfalls associated with their application to parasitic helminths.
THE NEUROBIOLOGY/NEUROPHARMACOLOGY OF ECTOPARASITES. J.R. SAUER*. OKLAHOMA STATE UNIVERSITY. STILLWATER, OK 74058.

There is considerable evidence that acetylcholine, octopamine and dopamine are neurotransmitters in synapses of the central nervous system and target tissues of ectoparasites. γ-aminobutyric acid may be a neurotransmitter at inhibitory synapses in the central nervous system and muscle of ticks. Glutamate appears to be a neurotransmitter at the neuromuscular junction and other results suggest possible receptors for glutamate and aspartate in ticks. Evidence is accumulating that neurosecretory peptides are present in the nervous system of ectoparasites; however, their sequence and roles in controlling biological functions are mostly unknown at this time.

As the identity of neurotransmitters, signalling mechanisms and properties of receptors become known, it may become possible to take advantage of differences between the parasite and other animals to develop pesticides having greater selectivity for controlling ectoparasites.

RESULTS OF CLINICAL TRIALS IN CATS AND DOGS, USING LUFENURON, AN INSECT DEVELOPMENT INHIBITOR. S.C. PARKS, CIBA-GEIGY ANIMAL HEALTH R&D, GREENSBORO, NC

Multi-centered, controlled, clinical field trials of an insect development inhibitor, administered orally to pets, were conducted during the spring, summer, and fall of 1990. Efficacy was assessed when used for either preventing the build up of a flea infestation (beginning administration prior to "flea season"), or as an adjunct to control measures when treatment is begun in the midst of a flea infestation. Households consisting only of cats, only of dogs, and combinations of cats and dogs participated. Lufenuron was administered monthly to dogs (10 mg/kg) and cats (30 mg/kg). Monthly counts of the number of fleas on the study animals was used to measure efficacy.

Initiating dosing prior to the onset of a flea infestation, resulted, after four months, in those animals receiving the drug, averaging approximately 3 fleas per dog, compared to 50 per dog in the control group. Cats averaged 5 fleas per cat when dosed with lufenuron, compared to 87 per cat in the control group. Administration to animals already experiencing flea infestations, resulted in a decrease from 67 to 10 fleas per dog and from 21 to 8 fleas per cat, after 60 days, and the numbers continued to decline for the next four months. No adverse reactions were noted in either cats or dogs, and the drug was administered concomitantly with a wide range of therapeutic agents.
EFFICACY OF LUFENURON, A BENZOYLPHENYL UREA, FOR CONTROL OF PRE-ADULT STAGES OF CTENOCEPHALIDES FELIS ON CATS. B.L. BLAGBURN, C.M. HENDRIX, J.L. VAUGHAN, D.S. LINDSAY AND S. BARNETT. AUBURN UNIVERSITY, AL 36849 AND CIBA-GEIGY ANIMAL HEALTH, GREENSBORO, NC 27410.

Lufenuron (CGA-184699), a benzoylphenyl urea insect development inhibitor, has been shown to be effective in the control of fleas when administered orally to mammalian hosts. Oral efficacy in dogs has been reported earlier. We describe the efficacy of lufenuron against pre-adult stages of the cat flea Ctenocephalides felis following oral administration to cats. Thirty-two, mature male and female cats were divided into 4 groups of 8 cats each. Each cat was housed in a stainless steel cage with a wire mesh floor to aid in collection of flea ova. Cats in groups 2, 3, and 4 were treated orally with lufenuron suspension at doses of 10, 20, or 40 mg/kg BWT, respectively, on day 0. Cats in group 1 were given placebo suspension. All cats were infested with 100 newly emerged, unfed adult C. felis at weekly intervals on days 3-63. Flea ova were collected from beneath cat cages 72 hours following each infestation and placed in flea rearing medium in an insectary. Emerged adult fleas were enumerated following a 28-day incubation. Reductions in mean numbers of emerged adult fleas from ova produced by fleas on treated cats compared to those on control cats on days 32 and 63 were as follows: 10 mg/kg, 32 days (63%), 63 days (32%); 20 mg/kg, 32 days (80%), 63 days (65%); 40 mg/kg, 32 days (98%), 63 days (96%). Lufenuron was safe and demonstrably effective in controlling infestations of C. felis on cats when administered at dosages of 20 mg/kg BWT or higher.

SAFETY EVALUATION OF LUFENURON IN DOGS AND CATS. WILLIAM R. CAMPBELL, CIBA-GEIGY CORPORATION, ANIMAL HEALTH DIVISION, GREENSBORO, NC 27410

Target animal safety studies have been conducted in dogs and cats with CIBA-GEIGY’s new insect development inhibitor, lufenuron. Lufenuron belongs to the benzoylphenyl urea class of chemicals and acts by inhibiting the normal synthesis of chitin. These studies were conducted at many multiples of the single monthly ad usum dose given frequently throughout most studies. Acute (single dose), sub-chronic (multiple doses over a short time period), and chronic (multiple doses over a long time period) studies were conducted in dogs while acute, sub-chronic and reproduction studies were conducted in cats. Sub-chronic studies were also conducted in dogs and cats where commonly used flea adulticides were applied on the lufenuron-treated animals. Results in all studies indicate that lufenuron is well tolerated by both dogs and cats. In the chronic dog study, up to 5x (50 mg/kg) was given 3 times monthly to young animals until they were one-year of age; no adverse-effects were observed. No compound related effects were noted in the cat studies. The studies in dogs and cats where lufenuron was used simultaneously with other flea adulticides did not indicate any enhanced signs of toxicity.
EFFICACY AND SAFETY OF FENOXYCARB PET SPRAY FOR CONTROL OF CTENOCEPHALIDAE FELIS INFESTATIONS ON DOGS AND CATS. A. A. MARCHIONDO*, S. ACKERS, S. W. FOGT, D. L. HEIMBICHNER, FERMENTA ANIMAL HEALTH CO., KANSAS CITY, MO 64153 AND R. YOUNG, YOUNG VETERINARY RESEARCH, MODESTO, CA 95356

Fenoxycarb, ethyl [2-(4-phenoxyphenoxy) ethyl] carbamate, is an insect growth regulator that exhibits strong juvenile hormone activity against the developing stages of the cat flea. A pet spray formulation containing the active ingredients (% w/w): fenoxycarb (0.10), S-bioallethrin (0.10), permethrin (0.15), piperonyl butoxide (0.50), MGK-264 (1.00) and MGK-326 (0.20) was evaluated for adulticidal and ovicidal activities against flea infestations on dogs and cats. Within the scope of this study, a single application of the formulation administered according to label directions provided: 1. greater than 90% adulticidal activity against adult cat fleas for 14 days post-application (DPA), 2. a mean ovicidal efficacy of 98 and 99% against shed flea eggs from dogs for 77 DPA and cats for 84 DPA, respectively, and 3. a mean efficacy of 99% against adult flea emergence from shed flea eggs from both dogs and cats for 91 DPA. No adverse results in dogs, cats, puppies and kittens were observed as a result of normal use-application of the formulation at 1X and 4X concentration of active ingredients applied at seven day intervals for three consecutive weeks. In addition, no adverse results in kittens were observed as a result of normal use-application of the formulation at 1X applied for four successive applications on a single day allowing for drying time between applications.

INSECTICIDE EAR TAGS - PAST, PRESENT AND FUTURE. J. L. RINER, FERMENTA ANIMAL HEALTH COMPANY, KANSAS CITY, MISSOURI 64153.

Ear tags containing organophosphate insecticides were developed in the late 1970's for control of the Gulf Coast ear tick, Amblyomma maculatum. The tick, an economic pest itself, was especially significant because its bite created an oviposition site for the primary screwworm, Cochliomyia hominivorax. Observations during tick evaluations showed that insecticide ear tags also provided control of the horn fly, Haematobia irritans. Ear tags containing a pyrethroid (fenvalerate) were introduced in 1981 specifically for control of flies on cattle. By 1983 widespread use of pyrethroid based tags created horn fly populations which were resistant to this group of compounds. Efforts to control pyrethroid resistant horn flies led to the development and introduction of a tag containing 20% diazinon in 1987. Tags containing the highly active pyrethroids lambdacyhalothrin and cyfluthrin were introduced in 1990 and 1991, respectively. An improved diazinon formulation has been developed recently and was introduced in the spring of 1992. This new formulation contains 40% diazinon and provides twice the release of pesticide as earlier diazinon formulations. Field trials have shown that a single 40% diazinon tag provides the same level of efficacy against horn flies as two 20% diazinon tags.
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The filariform larva (L3) of *S. stercoralis* is an environmentally resistant infective stage able to recognize a suitable host, initiate penetration, and resume development. To understand this activation process, we have studied the sensory neuroanatomy of this nematode. A 3-dimensional reconstruction revealed 6 internal and 6 external labial sensilla, as well as 4 cephalic sensilla. These sensilla do not open to the environment; they are probably mechano- or thermoreceptors.

The amphids, generally considered the main chemoreceptors, are open to the environment and contain 13 neurons, some of which are likely to be involved in the activation process. In *Caenorhabditis elegans*, a related free-living nematode, the neurons required for emergence from the developmentally arrested dauer stage have been identified through laser ablation studies. Comparing the amphidial neurons of *S. stercoralis* with those of *C. elegans* for homologues will allow us to initiate neuronal laser ablation studies to elucidate parasitic activation.

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M.J. COYNE*, SMITHKLINE BEECHAM, 812 SPRINGDALE DRIVE, EXTON, PA 19341 AND G. SMITH, DEPARTMENT OF CLINICAL STUDIES, NEW BOLTON CENTER, 382 WEST STREET ROAD, KENNETT SQUARE, PA 19348. PROCESSES WHICH REGULATE AND CONTROL THE FREE-LIVING AND PARASITE STAGES OF HAEMONCHUS CONTORTUS.

The elements of a mathematical model for the population biology of *Haemonchus contortus* will be presented. These include the results of experimental studies of the demography of the free-living stages, including the first systematic examination of the mortality and development of first- and second-stage larvae under conditions of constant temperature and humidity. We argue that previous exposure of lambs to the parasite has no effect on parasite fecundity. Nevertheless, parasite mortality does increase with the hosts' experience of infection, although the duration of the lambs' immunological memory of moderate *H. contortus* infection is less than nine weeks. Incorporating each of these elements into a mathematical model yields results that compare well with independent field data.
INITIATION OF FEEDING IN THE DEVELOPMENT OF HAEMONCHUS CONTORTUS LARVAE.
H.R. GAMBLE* AND L.S. MANSFIELD. USDA, ARS, LPSI, HELMINTHIC DISEASES
LABORATORY, BELTSVILLE, MARYLAND 20705.

Under appropriate conditions, infective larvae of Haemonchus contortus can develop to fourth stage larvae (L4) in vitro in a minimal salts medium. Subsequent development beyond the L4 in vitro is limited even in the presence of nutritionally complex media. These observations suggest that the acquisition of host nutrients in vivo is not required for parasite development until after the third molt occurs.

Exsheathed third stage larvae of H. contortus maintained in Earle's balanced salt solution at 37 C in 10% CO2 molted to L4 between 48 and 96 hours in culture. Parasite feeding, as assessed by the ingestion of fluorescein isothiocyanate, began coincident with the molt, with numbers of feeding worms equivalent to numbers of L4. Culture fluids collected from worms maintained in vitro for 72 or 96 hours, contained acid phosphatase and zinc metalloprotease activity; enzyme release was not a function of worm death, as >98% of worms remained viable following 120 hours of in vitro maintenance. These enzymes were absent prior to molting to the L4 (at 24 and 48 hours in culture) and appeared coincident with the initiation of the worm feeding response. The metalloprotease collected from worm cultures was distinct from a previously identified metalloprotease mediating the ecdysis of infective larvae, in molecular weight, substrate specificity, and temporal expression. Functions of this protease might include an involvement with casting of the third-molt cuticle, or digestion of host molecules, either externally or as a gut-associated enzyme.

A ZINC METALLOPROTEASE FROM CULTURE FLUIDS OF TRICHURIS SUIS ADULTS.

Trichuris suis is a nematode parasite of swine whose distribution and infectivity closely mimics that of Ascaris suum. The infection is highly pathogenic in swine, causing anemia, weight loss, anorexia, mucocoiling hemorrhagic diarrhea, and death in heavy infections, and is considered a major cause of economic loss to the swine industry. Much of the pathogenicity in T. suis infections is associated with the burrowing activities of the larval and adult stages.

A zinc-metalloendoprotease which may be involved in the development of pathology has been isolated from in vitro culture fluids of Trichuris suis adults. The protease was purified from total culture fluids by passage through a cation exchange high pressure liquid chromatography column. The 43kDa protease has a pH optimum of 7.0, an isoelectric point of 8.0, and was localized to the stichosome of the parasites using immunohistochemistry techniques. Antibody to the protease could be detected in infected animals as early as day 21 of infection. Cross reactive epitopes within the protease are shared among some common swine nematode parasites.
THE OCCURRENCE OF PHENOL OXIDASE ACTIVITY IN FEMALE *TRICHURIS SUIS*.

The body of *Trichuris suis* females maintained in vitro under a gas phase of 95% air 5% CO2 develops a brown pigment (tanning) that is apparent after 1 day and intensifies with time. Development of the tanning is prevented by maintaining the parasites in an anaerobic gas phase (95% N₂, 5% CO₂), but tanning commences when worms are returned to aerobic conditions. Tanning was not observed in males. Intact female *T. suis* take up oxygen at a considerably higher rate than males. Both supernatants and pellets from whole worm homogenates of females converted dihydroxyphenylalanine (DOPA) to colored product, DOPAchrome indicating the presence of a phenoloxidase enzyme. About 70% of the total phenol oxidase activity in females was in the pellet and about 30% in the supernatant. Homogenates of male worms contained minimal phenol oxidase activity. Polarographic assay of phenol oxidase activity confirmed the presence of this enzyme in female *T. suis*. Female homogenates oxidized both DOPA and 4-methylcatechol, and to lesser extent hydroxyquinone. This oxidation was inhibited (>90%) by diethyldithiocarbamate. Males did not oxidize any of the substrates tested. These results suggest that an enzyme of the phenol oxidase type is present in female worms but is probably inactive because of low oxygen tensions in the swine colon. The function of this enzyme in *T. suis* is unknown but is most-likely associated with tanning of eggshell proteins or other aspects of eggshell synthesis.

RAPID DEVELOPMENT OF PCR ASSAYS FOR DIAGNOSTIC PARASITOLOGY.
J.N. MACPHERSON and A.A. GAJADHAR*. HEALTH OF ANIMALS LABORATORY, AGRICULTURE CANADA, SASKATOON, SASK., CANADA S7N 2R3.

The PCR method is a powerful tool for both the research and diagnosis of infectious organisms. Use of this procedure has been limited by the requirement for previously determined nucleic acid sequence information. This was necessary in order to choose unique regions that could function as targets for primers. Consequently, developed PCR methods have been limited to regions of the genome that have been cloned and sequenced. We evaluated the usefulness of the recently described approach of random amplified polymorphic DNA (RAPD) in developing effective assays for the diagnosis of parasitic infections. Random sequences of short oligonucleotides were used to target arbitrary segments of an organism's genome, which were then amplified by PCR and evaluated by gel electrophoresis. Useful primers were selected and used in PCR assays to generate DNA fragments that showed species-specific electrophoretic patterns. We have identified single primers that can distinguish a variety of protozoan and nematode parasites. They include *Toxoplasma gondii*, *Sarcocystis* spp., *Eimeria* spp., and *Trichinella spiralis*. 
DIFFERENTIATION OF TRICHOSTRONGYLE EGGS USING GENERA SPECIFIC DNA PROBES. C.M. CHRISTENSEN*, L.C. GASBARRE AND D.S. ZARLENGA. USDA, ARS, LPSI, HELMINTHIC DISEASES & BIOSYSTEMATICS PARASITOLOGY LABORATORIES, BELTSVILLE, MD 20705.

Trichostrongyle eggs excreted in the feces of infected cattle cannot be morphologically differentiated at the genus level. In order to address this problem, genera specific DNA probes have been constructed. For this purpose, genomic DNA isolated from adult stages of Ostertagia ostertagi, Haemonchus placei, Cooperia oncophora and Oesophagostomum radiatum was partially digested with SAU 3A and ligated into the BanH1 site of pUC18 plasmid DNA. Escherichia coli JM83 cells were transformed and 420 clones were picked from each library and transferred to Nytran® filters. The libraries were initially screened with radiolabeled homologous genomic DNA to identify clones with highly repetitive sequences. Sublibraries of positively reacting clones were selected, plated out in quadruplicate and differentially screened with radiolabeled trichostrongyle genomic DNA from each of the four genera. Specific clones have been identified and partially characterized for each of the four parasites examined. Additional work has entailed hybridization of the probe DNA with genomic DNA derived from eggs isolated from feces. Preliminary work utilizing these probes demonstrated that the DNA extracted from less than 1000 eggs from a monospecific infection was sufficient to yield a positive reaction.

DEVELOPMENT AND CHARACTERIZATION OF A MONOCLONAL ANTIBODY AGAINST TACHYZOITES OF NEOSPORA CANINUM. R. A. COLE*, D. S. LINDSAY, B. L. BLAGBURN, AND J. P. DUBEY. DEPARTMENT OF PATHOBIOLoGY, AUBURN UNIVERSITY, ALABAMA 36849 AND ZOONOTIC DISEASES LABORATORY, BELTSVILLE, MARYLAND 20705.

A murine monoclonal antibody was developed against tachyzoites of the NC-1 isolate of Neospora caninum. An indirect immunofluorescence antibody test demonstrated that this monoclonal antibody (6G7) reacted with air-dried tachyzoites of Neospora caninum. The monoclonal antibody, isotype IgG2a, bound to the entire surface of the tachyzoite, and did not cross-react with air-dried tachyzoites of the RH isolate of Toxoplasma gondii. Specificity was further supported by the lack of cross-reactivity with sporozoites of Isospora suis, Eimeria bovis and Eimeria tenella, and first generation merozoites of Eimeria bovis.
USE OF HEARTWORM SERUM ANTIGEN TESTS TO MONITOR CLINICAL TREATMENT RESPONSE TO A NEW INVESTIGATIONAL ADULTICIDE (RM 340).

D. M. KEISTER1, J. BROWN2, H. WINOGRAD1, J. MCCALL2, M. DZIMANSKI2. 1 RHONE MERIEUX INC., ATHENS, GEORGIA 30601; 2 UNIVERSITY OF GEORGIA, ATHENS, GEORGIA 30602.

An intra-venous D. immitis transplant model was utilized to determine the efficacy spectrum and dose of RM 340. Also, controlled trials in naturally infested subjects were conducted to confirm worm kill and clearance, and to establish the utility of an in-office (Assure®/CH) diagnostic test to monitor RM 340 treatment response. These trials showed that the test was useful when applied at least 3 months post-treatment and accurately reflected treatment response.

In clinical trials, preliminary data has shown approximately 78% of pets seroconvert after one series of RM 340 when tested 4 months later. After a second series > 95% seroconvert. These data indicate that the transplant model is predictive of clinical seroconversion rates and that in-office antigen testing can be utilized to both diagnose and monitor adulticide treatment.

CHARACTERIZATION OF EIMERIA TENELLA UNSPORULATED OOCYST-SPECIFIC cDNA CLONES. R.G. HERBERT*, AND M.A. FERNANDO. DEPARTMENT OF PATHOLOGY, UNIVERSITY OF GUELPH, GUELPH, ONTARIO, CANADA N1G 2W1

Eimeria tenella is a major disease causing coccidian parasite of the domestic fowl. Oocysts passed in the feces of the infected host undergo an oxygen-dependent process called sporulation. Little is known about the molecular events that occur during this complex process which results in the formation of the infective stages called sporozoites.

In this study, 4 cDNA clones whose cognate RNAs are expressed in both unsporulated and sporulating oocysts but not in other life cycle stages were characterized. Each of the cDNA clones is unique and each corresponds to a separate locus. Two of the clones are located on E. tenella chromosome 7 and the other two on chromosomes 5 and 6 respectively. One may be a member of a divergent, polydispersed multigene family. Finally, the cognate RNAs for each of the cDNA clones show differential patterns of hybridization during oocyst sporulation. The levels of RNA are low at the start of sporulation, increase to peak levels at 6.5 to 23 hr after the onset of sporulation and, in each case, decrease to low hybridizing levels at 48 hr after initiation of sporulation. The results to be presented suggest that RNA expression during sporulation can be regulated by the level of the available transcript or by altering its primary structure.
NEOSPOROSIS ASSOCIATED WITH STILLBIRTH IN A GOAT. J.P. DUBEY*, H.M. ACLAND AND A.N. HAMIR. ZOONOTIC DISEASES LABORATORY, LPSI, ARS, USDA, BELTSVILLE, MD 20705 AND LABORATORY OF LARGE ANIMAL PATHOLOGY, SCHOOL OF VETERINARY MEDICINE, UNIVERSITY OF PENNSYLVANIA, KENNETT SQUARE, PA 19348.

Neospora caninum-like parasites can cause abortion and neonatal mortality in cattle, sheep, horses and dogs. We document a natural Neospora infection in a stillborn goat. The carcass of a near term, stillborn pygmy goat from a farm in Quarryville, Pennsylvania was necropsied. The main lesions were in the brain and consisted of nonsuppurative encephalitis. Glial nodules and thick-walled N. caninum tissue cysts were scattered throughout the brain. Some tissue cysts were degenerating. Tissue cysts stained with anti-N. caninum serum in an avidin-biotin complex immunohistochemical test.

OCCURRENCE OF CLINICAL LUNGWORM INFECTION (PROTOSTRONGYLUS RUFESCENS) IN A SHEEP FLOCK IN MARYLAND. L.S. MANSFIELD* AND H.R. GAMBLE. USDA, ARS, LPSI, HELMINTHIC DISEASES LABORATORY, BELTSVILLE, MARYLAND 20705.

Sixteen percent (16%) of 31 ewes and 25% of 16 rams maintained at the USDA, Agricultural Research Service, Helminthic Diseases Laboratory in Beltsville, Maryland were found to be infected with the lungworm Protostongylus rufescens. This nematode has not been reported in domestic sheep in the United States since 1950 (Mapes and Baker, 1950). In that single case report no mention was made of clinical signs or pathology attributable to the parasite. However, lungworm has been responsible for considerable mortality in bighorn sheep in the United States and domestic sheep in Europe and the Soviet Union. In the present study, infection with P. rufescens caused diarrhea, weight loss, and respiratory signs in sheep, which ranged from mild to severe, including one death.

Transmission of lungworm occurs through the ingestion of infected snail or slug intermediate hosts. Natural transmission of P. rufescens to parasite naive lambs grazing on pasture occurred during two consecutive years (1990, 1991). In 1991, 42% of 24 lambs acquired lungworm infections. Three lambs born to infected ewes during this study were not infected, suggesting that vertical transmission did not occur. Additionally, cattle grazing the same pastures as infected sheep were not infected with the parasite. Lungworm infection in domestic sheep in the United States may be under-reported. The parasite is easily detected by Baermann examination, but this procedure is little used by practitioners. Lungworm infection should be considered as a differential diagnosis in sheep exhibiting nonspecific respiratory signs.
THE PREVALENCE OF GASTROINTESTINAL PARASITES IN U.S. BEEF AND DAIRY CATTLE

G.H. MYERS, *1, E.A. KEITH 1, D.H. BLISS 2, J.E. MILLER 3, I. HAGSTEN 1

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A survey was conducted to determine the prevalence of gastrointestinal parasites in cattle. Fecal samples were examined using a centrifugal sugar flotation method. From 10/1/89 to 1/1/92 a total of 9,607 samples were examined from beef calves, yearlings/heifers, and cows/bulls. At the same time 1,372 samples were examined from dairy animals in the same age categories. The five most common helminth parasites detected on positive farms were:

Prevalence (%) of five helminths in U.S. Beef and Dairy Cattle

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Calves</th>
<th>Yearlings</th>
<th>Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Complex</td>
<td>60</td>
<td>79</td>
<td>80</td>
</tr>
<tr>
<td>Nematodirus</td>
<td>45</td>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>Cooperia</td>
<td>16</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Moniezia</td>
<td>3</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Bunostomum</td>
<td>11</td>
<td>16</td>
<td>6</td>
</tr>
</tbody>
</table>

*1 Hot Complex = (Haemonchus, Ostertagia, Trichostrongylus)

ARE THERE ANY CLINICAL CASES OF OVINE GASTROINTESTINAL NEMATODIASIS IN ARIZONA? R.C. BERGSTROM*, ED BICKNELL UNIV. OF ARIZONA, TUCSON, 85721 AND R.C.B., UNIV. OF WYO, LARAMIE 82070

Few or no research results of possible gastrointestinal worm problems in cattle in Arizona have been published during the past 20-30 years. Our current surveys have shown that three of the thirteen ranches (with mostly adult cows) checked from Nov. '89-Apr. '91 had mean worm egg counts of 45 or above and during Nov. '90-Apr. '91, three of twelve herds checked had mean egg counts of 48, 76 and 89. Most of the higher egg counts were from feces of yearling heifers or two-year-old cows. In most cases, 20-35 cattle from each ranch were checked. Ostertagia sp., Cooperia spp., and, in some herds, Nematodirus sp. dominated, numerically, however, Haemonchus sp., Trichostrongylus sp., as well as a few Strongyloides sp. and Bunostomum sp. in a few fecal samples were noted. Moniezia sp. and Eimeria zuernii and E. bovis were noted. Results will be compared to recent surveys in Wyoming.

Ack! '89-'90 Smith-Kline-Beecham: '90 - '91 Pittman-Moore
Both years: Vet. Sci., U. of AZ, Dr. C. Sterling
Extension, U. of AZ, Dr. Cy Card
SEVERE FLEA INFESTATION IN DAIRY CALVES. M.W. Dryden* and A.B. Broce. Departments of Laboratory Medicine* and Entomology. Kansas State University, Manhattan, Kansas 66506.

In June 1991 an investigation was conducted of a severe flea infestation in 23 holstein dairy calves in South Central Kansas. The flea infestation had become so severe that the owners reported the death of three calves they attributed to fleas. Inspection of the dairy revealed massive numbers of fleas on calves and in the barn they were housed. Fleas collected were identified as *Ctenocephalides felis*, cat fleas. Three lighted flea traps were used during the investigation to monitor changes in flea population levels in the environment. During the investigation 92,000 fleas were collected in these traps. Total flea recovery attempts from two calves resulted in 2,808 and 5,317 fleas being removed. Analysis of blood samples from ten calves revealed that nine of them had mild to severe anemia. A management program was recommended consisting of treatment of calves (permethrin – methoprene) and premises (chlorpyriphos – methoprene), removal of straw bedding from barn and reduction of stray cat population. Inspection of dairy nine weeks after control program was instituted revealed that fleas were not evident on calves or in the premises.

PREVALENCE OF SARCOPTIC MANGE AND DERMATITIS IN SLAUGHTER HOGS IN ONTARIO, CANADA. G. CHARBONNEAU1*, C. PICHE2, A. VILLENEUVE3, P. BAHNSON4 AND R. GARCIA5. 1STRATFORD, ONTARIO, 2MSD AGVET, KIRKLAND, QUEBEC, 3UNIVERSITY OF MONTREAL, ST-HYACINTHE, QUEBEC, 4UNIVERSITY OF MINNESOTA, MINNEAPOLIS-ST. PAUL, 5MSD AGVET, WOODBRIDGE, N.J.

A study was conducted in Ontario, Canada to determine the prevalence of sarcoptic mange and dermatitis in slaughter hogs in this region. Ears were collected at slaughter from 2168 pigs from 73 herds for the detection of mites. In addition, 2064 carcasses from 62 of the 73 herds were examined for the severity and distribution of dermatitis at slaughter and individually scored on a scale of 0 (no lesions) to 3 (severe dermatitis). Based on management practices, herds were classified as "high-health", "conventional" or "status unknown".

Mange mites were detected in scrapings from 45 of 73 herds (61.6%) from 265 of the 2168 (12.2%) pigs examined. Of the 45 positive herds, mange mites were detected in 18 of 22 (81.8%) status unknown herds (659 pigs, 120 positive), 25 of 37 (67.6%) conventional herds (1065 pigs, 137 positive) and 2 of 14 (14.3%) high-health herds (444 pigs, 8 positive). The average dermatitis score of herds which were evaluated was 0.51 for negative herds (N=19 herds, 628 pigs) and 1.27 for positive herds (N=43 herds, 1436 pigs). The results of this study indicate *Sarcoptes scabiei* is a common parasite in slaughter hogs in Ontario and suggest dermatitis scoring may be a valuable tool to monitor the mange status of herds.

Spinal cord homogenate from a native Panamanian horse with clinical signs and characteristic lesions of equine protozoal myelitis (EPM) was inoculated onto monolayers of bovine monocytes (M617). Schizonts were observed 13 weeks post-inoculation. Merozoites were arranged in rosette patterns around a central residuum or in irregular groups. Organisms divided by endopolygeny and lacked rhoptries. Schizonts reacted with S. cruzi antiserum in an immunohistochemical test. Merozoites cultured from the present case were compared to a North American S. neurona isolate by immunoblot analysis. Serum from the affected horse reacted with two bands in the homologous merozoite protein profile that were not detected in the profile of the North American isolate. Serum from a horse injected intravenously with the North American S. neurona isolate reacted with one band in the homologous merozoite protein profile that was not detected in the profile of the Panamanian isolate.

LOCAL LYMPHOID CHANGES AFTER OSTERTAGIA OSTERTAGI INFECTION IN NAIVE AND PREVIOUSLY IMMUNIZED CALVES. L.C. GASBARRE AND A. CANALS. USDA, ARS, LPSI, HELMINTHIC DISEASES LABORATORY, BELTSVILLE, MD 20705, AND I.N.I.A., MADRID, SPAIN.

Previous work has shown that drug attenuated O. ostertagi infections can confer a significant level of protective immunity to subsequent experimental challenge with infective larvae. The purpose of these studies was to begin to define the changes in the local lymphoid tissues that accompany infection in naive and immune calves. Abomasal lymph nodes were taken from calves beginning as early as 2 days post infection. Phenotypic changes in the resulting lymphocytes population were assessed by flow cytometry, and changes in antigen specificity were determined by limiting dilution analysis utilizing antigen derived from fourth-stage O. ostertagi or adult Oesophagostomum radiatum. Primary infection of naive calves caused a rapid decrease in the percentage of T cells, and a corresponding increase in immunoglobulin bearing cells. This decrease in T cell percentage is due to a decrease in cells bearing the CD4 marker, a marker usually associated with helper T cells. Immunized calves were able to maintain normal T cell percentages until later in the challenge infection. The frequency of T cells responding to parasite antigen increased in both groups, but the total number of cells responding was higher in the immunized calves due to a greater lymph node enlargement in these animals. The target for this immunity is uncertain, but previous exposure appeared to delay development of the larvae and also resulted in significantly smaller worms after challenge.
THE EFFECT OF MOXIDECTIN ON BOVINE GASTROINTESTINAL NEMATODES.

Moxidectin was evaluated against bovine gastrointestinal parasites at 0.1, 0.2, 0.3 and 0.4 mg/kg by measuring eggs/gram (epg) reduction and comparing nematode numbers in treated and untreated calves. Moxidectin at 0.2-0.4 mg/kg was 100% effective in reducing epg at 12 days post treatment. Nematode reduction was 100% for Haemonchus placei, Ostertagia ostertagi, and Oesophagostomum radiatum at 0.1-0.4 mg/kg. It was 89% effective against Cooperia pectinata and 99% effective against G. punctata at 0.1 mg/kg. At 0.4 mg/kg it was 100% effective against all nematodes evaluated.

DOSE TITRATION OF MOXIDECTIN 1% INJECTABLE AGAINST RUMINANT HELMINTHS
G. T. WANG* AND D. ROCK. AMERICAN CYANAMID COMPANY, P.O. BOX 400, PRINCETON, NEW JERSEY, U.S.A., 08543

Four dose titration studies were conducted with moxidectin 1% injectable against natural nematode infections in various breeds of beef cattle in the U.S. In each of the four studies, five groups of six infected calves were injected subcutaneously with moxidectin at 0.1, 0.2, 0.3, or 0.4 mg/kg body weight or the unmedicated blank vehicle. Animals were slaughtered at 10-13 days posttreatment for differential worm counts. Excellent control (90-100%) was obtained with 0.1 mg moxidectin/kg b.w. against the adult and larval stages (including the inhibited larvae) of three abomasal species (Haemonchus placei, Ostertagia ostertagi, and Trichostrongylus axei) and the adult stage of 5 intestinal species (Cooperia punctata, Nematodirus helvetianus, N. spathiger, Oesophagostomum radiatum, and Trichuris ovis). In order to achieve good to excellent efficacy (80-100%) against C. pectinata, C. oncophora, C. mcmasteri (surnabada), and T. discolor, the dosage of moxidectin had to be increased to 0.2 mg/kg. Therefore, these four intestinal nematode species are the dose limiting species for establishment of the recommended dose of 0.2 mg moxidectin/kg for the effective control of internal parasites. No adverse reactions were observed with any of the treated animals.
EFFICACY OF CYDECTIN® MOXIDECTIN 1% INJECTABLE AGAINST GASTROINTESTINAL NEMATODE AND LUNGWORM INFECTIONS IN CALVES.
J.C. WILLIAMS,* C. NAULT, R.T. RAMSEY. LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA 70803

Target species in this evaluation were *Bunostomum phlebotomum* (Bp) and *Dictyocaulus viviparus* (Dv). Twenty-eight Holstein male calves (avg. 105 kg) were acquired in NOV and existing infections were retained. All were experimentally infected with Bp DEC 14 and with Bp and Dv on FEB 22. After JAN 1 the calves were rotated between holding pens and a small contaminated pasture at 5-10 day intervals. Based on a descending order of Bp egg-, and Dv L, counts on MAR 21, 20 calves were allotted into 2 groups of 10 and treated as follows: group 1-treated with moxidectin at 0.2 mg/kg b.w., by SC injection; group 2-nontreated controls, blank vehicle at 1 ml/50 kg b.w. by SC injection. They were necropsied for worm recovery at 13 and 14 days after treatment. Treatment was 100% effective in elimination of Bp eggs and Dv L, and 99.9% against total egg counts at 7 and 13 days PT. Moxidectin was 100% effective (P<0.01) against Dv mature and imm. adults, Bp adults and L4, *Ost. ostertagi* adults and early L4, *Ost. lyrata* adult males, *Haem. placei* adults, *T. axei* adults, *Cooperia* spp., including *C. punctata*, *C. spatulata*, and *C. pectinata* adults, *Oes. radiatum* adults, and *Trichuris discolor* adults.

EFFICACY OF INJECTABLE MOXIDECTIN AT TWO DOSE RATES AGAINST NATURAL GASTROINTESTINAL NEMATODE INFECTIONS OF BEEF CATTLE. J.A. STUEDEMANN*, H. CIOROIU, G.T. WANG, AND J. HUANG. USDA, ARS, WATKINSVILLE, GA 30677*, 2 THE UNIVERSITY OF GEORGIA, EXPERIMENT 30212 1 AND AMERICAN CYANAMID CO., PRINCETON, NJ 08540 2

Twenty-four yearling steer and heifer calves harboring natural nematode infections were used to evaluate anthelmintic efficacy of an injectable formulation of moxidectin. In each of two trials, 12 animals were randomly assigned to three groups of four calves on the basis of sex, and prettrial nematode egg counts. Treatments, including carrier only and moxidectin at 0.2 or 0.3 mg/kg of body wt., were then assigned to the groups of calves. In each trial, calves were necropsied 14 days posttreatment. Results in both trials were similar; therefore, the data were pooled. The geometric mean total worm count of control calves was 69,601. When compared to control calves, efficacy against abomasal adults at 0.2 or 0.3 mg/kg was 99.997 and 99.998%, respectively. Efficacy against inhibited *O. ostertagi* larvae was 100% at either dose rate. Efficacy against small intestine adults at 0.2 or 0.3 mg/kg was 99.851 and 99.966%, respectively. Efficacy against *Cooperia* spp.(L4) larvae was 98.626 and 100%, respectively. Efficacy against all forms of gastrointestinal nematodes at 0.2 or 0.3 mg kg body wt. was 99.978 and 99.995%, respectively. Moxidectin was very effective (P<.0001) against larval and adult nematodes at either dose rate.
DOSE TITRATION OF MOXIDECTIN POUR-ON IN CATTLE INFECTED WITH GASTROINTESTINAL NEMATODES. C.E. COUVILLION*, COLLEGE OF VETERINARY MEDICINE, MISSISSIPPI STATE UNIVERSITY, MISSISSIPPI STATE, MS AND F. GUERINO, AMERICAN CYANAMID COMPANY, PRINCETON, NJ.

Forty mixed breed beef calves naturally infected with gastrointestinal nematodes were assigned to 4 treatment groups. Groups 1, 2, and 3 received moxidectin pour-on at dose rates of 0.25, 0.50, and 0.75 mg/kg bodyweight, respectively. Group 4 received only the vehicle at 0.15 ml/kg body weight. Fecal egg counts were done on all animals prior to treatment and at 14 days after treatment. Animals were necropsied at 14 days post-treatment for recovery and counting of gastrointestinal nematodes. Post-treatment egg counts of groups 1-3 were significantly lower than pretreatment counts (p < 0.05), while the control group egg count did not differ from pretreatment levels (p > 0.05). There was no difference (p > 0.05) in worm counts of any of the treated groups. At all 3 dosages, moxidectin pour-on was highly efficacious (>98%) against Ostertagia ostertagi, Trichostrongylus axei, Cooperia punctata, C. spatulata, C. surnabada and Oesophagostomum spp., and 100% efficacious against inhibited early fourth-stage larvae of O. ostertagi and fourth-stage larvae of Cooperia spp. For C. oncophora the efficacy at 0.25 mg/kg bodyweight was 89.22% while the efficacy was 100% at 0.50 and 0.75 mg/kg. The prevalences of infection with fourth-stage larvae of Haemonchus placei, adults of Capillaria bovis, Strongyloides papillosus, Nematodirus helvetianus, Bunostomum phlebotomum, Trichostrongylus spp., and Trichuris ovis, were too low for a valid test of efficacy.


A controlled anthelmintic trial was carried out to evaluate the efficacy of 0 (controls), 0.25, 0.50, and 0.75 mg of moxidectin (MXN) /kg as a pour-on against naturally acquired parasite infections in 40 calves. The mean nematode egg count per gram of feces (NEPG) prior to treatment was 721.5, 842.0, 615.0, and 571.6 for the control, 0.25, 0.50, and 0.75 mg of MXN /kg treatment groups respectively. Reductions in NEPG between fecal samples obtained prior to treatment and at necropsy were 100, 99.95, and 100% for the 0.25, 0.50, and 0.75 mg of MXN /kg treatment groups, respectively. At all treatment levels MXN was 100% effective against Bunostomum phlebotomum, Oesophagostomum radiatum, and Trichostrongylus colubriformis. Efficacy against Cooperia spp adults ranged from 96.0-99.9%. Efficacy against Haemonchus placei was 92.6, 100, and 100% for calves treated with 0.25, 0.50, and 0.75 mg of MXN /kg respectively. Efficacy against Nematodirus helvetianus was 100.0, 97.0, and 100% for calves treated with 0.25, 0.50, and 0.75 mg of MXN /kg respectively. Efficacy against Ostertagia ostertagi was 99.9, 100, and 100% for calves treated with 0.25, 0.50, and 0.75 mg of MXN /kg respectively. Efficacy against 4th-stage O ostertagi was 97.5, 100, and 100% for calves treated with 0.25, 0.50, and 0.75 mg of MXN /kg respectively. Efficacy against T axei was 99.5, 99.7, and 100% for calves treated with 0.25, 0.50, and 0.75 mg of MXN /kg respectively. Efficacy against T axei was 99.7, 99.3 and 100% for calves treated with 0.25, 0.50, and 0.75 mg of MXN /kg respectively. Gross pathologic changes were not observed in the skin, subcutaneous tissues, or muscles surrounding the pour-on site of any of the calves. Systemic adverse reaction to treatment was not observed.
MOXIDECTIN: SYSTEMIC ACTIVITY AGAINST COMMON CATTLE GRUBS (HYPODERMA LINEATUM) (DIPTERA: OESTRIDAE) AND TRICHOSTRONGYLE NEMATODES IN CATTLE. P.J. SCHOLL AND G.T. WANG. AGRICULTURAL RESEARCH SERVICE, USDA. KERRVILLE, TX 78028. AMERICAN CYANAMID COMPANY. PRINCETON, NJ 08543.

Moxidectin, a systemic insecticide, was evaluated for efficacy against the migrating first instars of the common cattle grub, Hypoderma lineatum, and against nematode egg production in beef cattle. It was observed that all three levels (0.1, 0.2 and 0.4 mg Moxidectin/kg) were 100% effective against cattle grubs when administered as a subcutaneous injection. The same levels of treatment were very effective (90-100%) in reduction of trichostrongyle nematode egg production. However, there was a slight indication that at least one species, Cooperia oncophora, was not completely eliminated, as it was observed that small numbers of eggs began to appear after 2 weeks posttreatment with no opportunity for reinfection.

VACCINATION OF WEANED PIGS WITH A TEMPERATURE SENSITIVE MUTANT OF TOXOPLASMA GONDII. D. S. LINDSAY, B. L. BLAGBURN, AND J. P. DUBEY. DEPARTMENT OF PATHOBIOLOGY, AUBURN UNIVERSITY, ALABAMA 36849 AND ZOONOTIC DISEASES LABORATORY, BELTSVILLE, MARYLAND 20705.

Two experiments were performed to determine the effects of vaccination of 22- to 23-day-old weaned pigs with a temperature sensitive mutant (TS-4) of T. gondii. Experiment 1 was conducted to evaluate the safety of the vaccine. Four pigs were intravenously inoculated with 500,000, TS-4 tachyzoites and examined at necropsy 7, 16, 21, and 28 days postinoculation (PI); additionally, 2 pigs were subcutaneously (SC) inoculated with 500,000 tachyzoites and examined 17 and 29 days PI. Neither clinical toxoplasmosis nor death was observed in inoculated pigs. Toxoplasma gondii was not isolated from mice inoculated with nondigested porcine tissues. Results indicate that TS-4 is safe in weaned pigs. In experiment 2, four pigs were SC inoculated and boosted SC, 14 days PI with 500,000, TS-4 tachyzoites. Four control pigs received HBSS, SC on these occasions. All 8 pigs were orally inoculated with 100,000 oocysts of the GT-1 isolate of T. gondii 30 days after the initial immunization. Rectal temperatures of vaccinated pigs were lower than those of nonvaccinated pigs following oocyst inoculation. Control pigs appeared more lethargic than vaccinated pigs. Toxoplasma gondii was isolated from all 8 pigs following inoculation of mice with acid-pepsin digested porcine tissues. Results indicate that TS-4 may decrease the severity of disease following challenge with virulent T. gondii, but does not prevent tissue cyst formation under the vaccination conditions employed in this study. We thank Drs. Rene Popiel, PARAVAX, Inc., and James Fishback, University of Kansas Medical Center, for their assistance in obtaining the TS-4 isolate of T. gondii.
Optimum doses of gamma irradiation were determined for three coccidial species, *Eimeria acervulina*, *E. tenella*, and *E. maxima* whereby merogonic development was inhibited without affecting sporozoite invasion of intestinal cells. Protection against coccidial challenge was equivalent in chickens that had been immunized per os with non-irradiated or irradiated oocysts. Although sporozoites exposed to high doses of gamma irradiation (>20 kRad) were able to invade intestinal tissue, these parasites did not elicit a protective response. Immunostaining of cultured chicken cells infected with irradiated or non-irradiated parasites with a McAb that recognizes a "metabolic" antigen showed that protective forms of the parasite were metabolizing whereas non-protective forms were inactive. These findings suggest that immunity is induced by sporozoite-infected cells and that intracellular metabolism is required for establishing a protective response. Immunostaining of Western blots containing SDS-PAGE separated protein from an intestinal cell line infected with irradiated or non-irradiated sporozoites identified unique antigens shared by protective forms of the parasite. Sporozoites exposed to high levels of gamma irradiation (>20 kRad) did not produce these antigens. These antigens may represent targets of protective immunity against avian coccidiosis.

*Babesia divergens* is widely spread in cattle in Europe. Mortality rate is limited by chemotherapy. Nevertheless, the disease induces significant economical losses, specially in Ireland, Great Britain and France. Furthermore, *B. divergens* is also responsible for a severe disease in man, particularly in splenectomized patients who develop high parasitemia (up to 80%).

A vaccine strategy was developed against *B. divergens* bovine babesiosis. In this respect, a method of long term *in vitro* culture was first achieved. Culture in human erythrocytes gave higher parasitemia than culture in bovine erythrocytes: a 30-40% parasitemia could be routinely obtained in human erythrocytes with any *B. divergens* isolate.

Crude supernatants were collected from *in vitro* culture of *B. divergens* Rouen 87 (a human isolate). These supernatants were concentrated, mixed with Quil A saponin and used to immunize gerbils, a rodent highly susceptible to *B. divergens*. High protection was obtained against homologous and heterologous challenges by isolates from different geographic areas (France, United Kingdom, Germany). Furthermore, a vaccination trial in cattle clearly demonstrated that a crude *B. divergens* in *in vitro* supernatant can induce effective protection in cattle, even after immunosuppression by splenectomy.

The *B. divergens* Rouen 87 immunodominant exoantigens inducing an humoral response in ox, gerbil and man were identified as polypeptides of 37, 46, 70 and 90 kDa. Identification and purification of immunoprotective *B. divergens* polypeptides are in progress to produce a subunit vaccine.
A PHYLOGENICALLY CONSERVED GUT SURFACE ANTIGEN(S) OF HAEMONCHUS CONTORTUS AND ITS EFFICACY IN INDUCING PROTECTIVE IMMUNITY. D.P. JASMER*, L.E. PERRYMAN, S.L. CROW, G.A. CONDER® AND T.C. MCGUIRE. WASHINGTON STATE UNIVERSITY, PULLMAN WA, 99164 AND ®THE UPJOHN COMPANY, KALAMAZOO, MI.

Monoclonal antibodies (mAbs) were made against gut surface epitopes of H. contortus. mAbs were used to characterize the stage specific expression and phylogenetic conservation of these antigens. Gut surface antigens were then isolated by immunoaffinity chromatography and used in immunization experiments.

One mAb (43/10.6.1) recognized numerous antigens on western blots and reacted to several areas of adult worms including the gut, parts of the body wall and weakly to cuticular regions. The epitope was also detected on internal organs of third stage larvae. The epitope was sensitive to periodate treatment, suggesting it is a carbohydrate. This epitope is widely conserved phylogenetically, as it was detected in the gut and other tissues of various species including Ostertagia ostertagi, Trichostrongylus colubriformis, small horse strongyles, and Caenorhabditis elegans. In preliminary experiments, antigen isolated with this mAb induced immune responses in immunized goats resulting in a mean 46% reduction of adult worms compared to control goats. Based on the broad phylogenetic cross-reactivity of mAb 43/10.6.1, these results may have significant application toward identifying protective antigens of other gastrointestinal nematodes.

INVOLVEMENT OF BRAIN IN PLASMODIUM KNOWLESI Rhesus Monkey Model: IMMUNE PROTECTION STUDIES

Abbas Ali Mahdi and Raj Kumar Singh
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K.G. Medical College
Lucknow-226003, India.

The present study was undertaken to investigate the role of immunity in protection or in minimizing the course of pathogenic events in cerebral malaria. In our earlier studies we have used Plasmodium knowlesi -rhesus monkey model to investigate the involvement of brain during malarial infection. For the present studies rhesus monkeys were immunized against P. knowlesi whole antigen in combination with muramyl dipeptide (MDP) as an adjuvant. The P. knowlesi whole antigen was isolated and the purity of the antigen sample was assessed using IHA test. Animals were immunized using antigen alone and in combination with MDP. Monkeys receiving whole antigen and MDP combination showed survival rate of 50%. Animals belonging to control groups showed 100% mortality. Sections of brain from infected control animals revealed that the blood vessels were completely plugged with parasitized erythrocytes. However, there was virtually no parasitic infiltration in the immunized animals following challenge. On the basis of present studies it is suggested that inspite of apparent limitations, immunization does provide a satisfactory protective cover as far as fatal involvement of the brain tissue is concerned.

The development of acquired resistance to trichuriasis is inferred from the fact that infective eggs are ubiquitous and long-lived, but infections are mainly observed in growing pigs. There are, nevertheless, few reports on immunity to T. suis in swine. Procedures were developed for the in vitro cultivation of adult T. suis that result in the production of culture derived ESP that have enzymatic activity. A zinc metalloprotease was detected in the ESP, and an adult female derived phenyl oxidase, that could cross-link secreted proteins, was characterized. The immunological importance of the ESP was evaluated by immunizing pigs against a combined experimental inoculation and natural exposure. Four groups of 8 pigs each were injected at day 0 and 7 of the experiment as follows: 1) control (uninjected); 2) 2mg ESP in FCA i.m., then 1mg ESP in IFA i.p. (high dose Freunds); 3) 2mg ESP in alum i.p., then 1mg ESP in alum i.p. (high dose alum); 4) 0.6mg ESP in alum i.p., then 0.3mg ESP in alum i.p. (low dose alum). All pigs were challenged with 2000 eggs/kg b.w. and then placed on a dirt lot contaminated with T. suis eggs for 52 days. Immunized pigs had increased serum IgG, IgA and IgM antibodies to ESP. Control, unimmunized pigs had 2205 ± 465 T. suis adults recovered at necropsy, while immunized pigs had adult recoveries reduced by 31%, in the high dose Freunds group, 86%, in the high dose alum group, and 94%, in the low dose alum group.


Twelve yearling ponies raised parasite-free from birth were divided into 4 treatment groups of 3 ponies. Treatments were: oral administration of 500 radiation-attenuated S. vulgaris L₃; intramuscular injection of S. vulgaris adult worm homogenates plus RIBI adjuvant; injection of S. vulgaris L₃ and L₄ somatic homogenates, larval excretory/secretory products, and RIBI adjuvant; injection of RIBI and media as control. Six weeks following the second vaccination ponies were challenged orally with 750 S. vulgaris L₃. Six weeks following challenge, ponies were necropsied. Ponies which received S. vulgaris homogenates had higher and more prolonged periods of fever, anorexia, depression and weight loss following challenge, and more severe arterial lesions at necropsy. Following challenge, ponies vaccinated with attenuated S. vulgaris L₃ had significant anamnestic eosinophilias, fewer clinical signs, fewer arterial lesions, and reduced worm recoveries (92%) at necropsy. Homogenized worm extract vaccine recipients had higher ELISA titers and recognized more antigen bands pre- and post-challenge. Antibody alone is not protective and may be responsible for exacerbation of signs and lesions seen,

(Supported in part by Merck & Co., and Paravax Inc.)
Previously we reported that female BALB/c mice vaccinated s.c. with 5 or 10 live Heligmosomoides polygyrus fourth stage larvae (L4) were highly resistant to a virulent oral challenge with L3. The strength of the induced immunity was strain dependent with BALB/c mice developing strong resistance and C57BL/6 mice developing little or none. Evidence for stock animals indicates differences in breed and individual resistance to trichostrongylid infection and for the heritability of resistance to these parasites in sheep and cattle. Thus stock animals having diverse genetic backgrounds also may demonstrate disparate responses to s.c. trichostrongylid vaccine. The object of this research was to use the H. polygyrus model to determine if facile means could be developed to overcome the limitations imposed on the s.c. vaccine system by host genetic background. In the experiments either increased antigen load or an immune enhancing agent, interleukin 2 (IL-2) was used to convert nonresponder C57BL/6 mice to a responsive state similar to that observed with BALB/c mice. IL-2 was administered by placing constant release pellets (Innovative Research, Toledo, OH) of different strengths s.c. with the L4 vaccine. C57BL/6 mice receiving 50 or 100 L4 rather than 10 were highly resistant to challenge (>95% protection). C57BL/6 mice given 10 L4 and IL-2 had variable levels of resistance dependent upon the dose of IL-2. Mice receiving 3.6 μg of IL-2 were highly resistant to the challenge infection (>85% protection). Supported by Massachusetts Agricultural Experiment Station.
Review of *Nematodirus helvetianus*.
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Designing, Implementing and Monitoring Strategic Parasite Control Programs
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SERUM FROM DOGS INFECTED WITH *Dirofilaria immitis* DEPRESSES ENDOTHELIUM-DEPENDENT RELAXATION OF THE IN VITRO RAT AORTA. VICTORIA L LAMB*, JEFFREY F WILLIAMS, LANA KAISER. MICHIGAN STATE UNIVERSITY, EAST LANSING, MICHIGAN 48824

We have previously reported that heartworm infection depresses endothelium-dependent relaxation of the in vivo canine femoral artery. In addition, adult *D immitis* release biologically active factors that depress endothelium-dependent relaxation of rat aorta. Since the adults reside in the right heart and pulmonary arteries, it seems likely that biologically active factors produced by *D immitis* circulate in the blood and could alter endothelial cell function. We tested the hypothesis that filarial factors in serum from heartworm infected dogs depress endothelium-dependent relaxation of the in vitro rat aorta. Rings of rat thoracic aorta were preconstricted with norepinephrine, and dose-response relationships to methacholine (an endothelium-dependent vasodilator) and nitroglycerin (an endothelium-independent vasodilator) were done in the presence of serum from either heartworm infected or uninfected control dogs. Nitroglycerin relaxation responses were not different between groups. However, methacholine relaxation was significantly depressed in rings exposed to serum from heartworm infected dogs when compared to control. These results support our hypothesis that filarial factors present in the serum from heartworm infected dogs depress endothelium-dependent relaxation. Thus, circulating filarial factors have the potential to influence the behavior of any endothelial surface. (NIH-HL 25779 & HL 01842)


How avermectin anthelmintics eliminate gastrointestinal nematodes has not been precisely identified. Visual and radiometric assays of pharyngeal pumping in *Haemonchus contortus* demonstrated that ivermectin at concentrations ≥10⁻¹⁰ M inhibits ingestion. Quantitative measurements of *H. contortus* motility showed that paralysis of the body wall musculature was seen at ivermectin concentrations ≥10⁻⁸ M. Since oral ingestion seems to be essential for survival of gastrointestinal nematodes *in situ*, the primary anthelmintic action of ivermectin may be pharyngeal paralysis, resulting in starvation.

Further experiments confirmed that ivermectin can be used as a chemical ligature for *H. contortus* without impairing short-term viability *in vitro*. Using low concentrations of ivermectin to reduce pharyngeal pumping, it was shown that the worm acquires glucose primarily by transcuticular absorption rather than oral ingestion.
ORGANIC ACID EXCRETION BY *HAEMONCHUS CONTORTUS*: IMPLICATIONS FOR CUTICLE MICROENVIRONMENTAL pH REGULATION AND DRUG ABSORPTION.  

The adult stage of *Haemonchus contortus* excretes acetic, propionic and lactic acids, as well as propanol, ethanol and CO₂. Recent studies with *Ascaris suum* have indicated that organic acids are excreted across the cuticle at a rate of 0.1 μmol/cm²*h. This creates a microenvironmental pH of ~5.0 and relatively high buffer capacity within the aqueous pores of the cuticle, and thus influences the rate of absorption of weak acids and bases. To determine if a cuticle microenvironmental pH is also maintained by *H. contortus*, we measured organic acid excretion kinetics and the absorption of model weak acid and base compounds. Experiments were carried out using 25 worms in 1 ml of several physiological media which varied in buffer capacity (0.25 to 20 mM) and initial pH (3.25 or 7.5). To evaluate the importance of the cuticle as a pathway for excretion and drug absorption, the intestine was chemically ligated by adding 10⁻⁷M ivermectin. The pH changed from an initial value of 7.5 or 3.25 to an asymptotic value of 5.5. The rate of pH change depended on the buffer capacity but was not affected by chemical ligation. The rate of excretion of each organic acid was constant during the first 8-12 hours and was independent of the initial pH, buffer capacity and ivermectin. The absorption of benzoic acid, p-nitrophenol, and aniline was not affected by the initial medium pH. These results indicate that *H. contortus* excretes organic acid endproducts of carbohydrate metabolism across the cuticle. These acids appear to maintain a microenvironmental pH within the cuticle which can influence drug absorption.


In anthelmintic research, the use of quantitative, physicochemical approaches to improve the pharmacodynamic properties of drugs is limited by our lack of knowledge of important delivery issues. What physicochemical properties of drugs favor their absorption by parasites? Are the rates of drug absorption, and the factors that control them, similar for parasites and the host? How does parasitological infection influence drug absorption by the host? What is the relationship between drug absorption and efficacy?

To address these issues, we conducted a series of in vitro absorption kinetic studies using adult stage *Haemonchus contortus* and *Trichostrongylus colubriformis*. Anthelmintics tested included levamisole, ivermectin, fenbendazole, closantel and several β-ketoamides. The timecourse of drug action as a function of concentration was assessed by an automated in vitro motility assay. An acute, in situ intestinal perfusion model (infected and uninfected Mongolian gerbils) was used to assess compound absorption by the host.

Results of these studies demonstrate that the rate-determining barrier to anthelmintic absorption by nematodes is lipoidal in nature. In general, the physicochemical characteristics which favor absorption by nematodes and their hosts are similar. The timecourse of the effects of a drug on nematode motility is influenced by its potency and action mechanism, and also by the rate at which it is absorbed.
SATELLITE CLIMATOLOGY AND PATTERNS OF SNAIL BORNE DISEASE IN EGYPT.
J.B. MALONE*, P.A. WILSON, D.P. FEHLER, O.K.HUH AND ALI ELMAGDOUB.
LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA 70803 AND ALEXANDRIA
UNIVERSITY, ALEXANDRIA, EGYPT.

AVHRR day-nite pair spectral data for 16AUG90, 18OCT 90 and 14FEB91 from the NOAA-11
polar-orbiting satellite were processed using TERRASCAN software to produce georeferenced
maximum (Tmax), minimum (Tmin) and temperature difference (dT) images from channel 4
thermal data. Images were exported to an ERDAS image processing system for further analysis.
Temperature data were accurate to 0.2 C. An initial classification using Tmax, Tmin and dT
images for 16Aug90 was done. Non-agricultural desert areas were eliminated by dropping the
last 21 of 30 thermal classes and converting remaining mountainous areas to zero within polygon
outlines. The resulting image contained only the Nile delta and Nile basin and scattered pixels
outlining coastal areas; it was then used as a template to extract the identical area in the other
2 images. Analysis of the 16AUG90 image allowed delineation of 8 thermal regions that
correspond to agroclimatic zones described for Egypt by FAO. Patterns could be identified that
reflected the classic schistosomiasis prevalence regions described by Scott in 1937 (Am J Hyg
25, 566). The broad thermal domains seen in the 16AUG90 image were seasonally stable in
18OCT90 and 14FEB91 images. Data are being analyzed for relationships of thermal domains
to standard climate station data and underlying soil and hydrologic factors that influence
distribution of snail borne diseases in Egypt. (Supported by NIH Grant TMP R15-AI28192-01).

DEVELOPMENT OF A GROWING DEGREE DAY MODEL OF MINIMUM TIME FROM
INFECTION OF SNAILS TO CERCARIAL PRODUCTION FOR SCHISTOSOMA
HAEMATOBIIUM IN BULINUS TRUNCATUS AND SCHISTOSOMA MANSONI IN
BIOMPHALARIA GLABRATA. S.H. ZUKOWSKI* AND J.B. MALONE. LOUISIANA
STATE UNIVERSITY. BATON ROUGE, LA 70803.

The developmental null points, specific constant sums of time-temperature products and general
hyperbolic formula relating minimum time to patency of Schistosoma haematobium in Bulinus
truncatus and of Schistosoma mansoni in Biomphalaria glabrata, developed by Pfluger, et al (Z.
parasitenkd., (1981) 66:221-229 and (1984) 70:95-103) were adapted to a growing degree model
of schistosome development.

in 2 areas Rhodesia (hot and temperate) and for S. mansoni in B. glabrata in the temperate area
were used to verify the model. Regression analysis suggested good agreement of model to
observed times in each case (S. mansoni in B. glabrata: r² = 0.420, slope = 0.715, n = 13;
S. haematobium in B. truncatus: temperate area, r² = 0.0.689, slope = 0.651, n = 11; hot
area, r² = 0.969, slope = 0.769, n = 12).

Results will be used to develop hypothetical molluscide schedules for testing in control
programs for bilharzia and fascioliasis in Egypt. (Supported by NIH Grant TMP R15-AI28192-01).

Distribution of snail species known to be intermediate hosts for Fascioloides magna did not explain the fluke’s range in Minnesota. A study was conducted to compare the potential of Lymnaea caperata, L. palustris, and L. catascopium, which were all found within the endemic fluke range, to serve as intermediate hosts for F. magna. Twenty-four snails of each species were infected individually with six miracidia, and observed at intervals throughout the infection. By 28 days post infection (PI) snails of all three species showed evidence of infection, and cercariae were shed by day 45 PI. All surviving snails were crushed on day 84 PI and metacercariae counted. The three species differed in their cercariae production potentials. A total of 7784 metacercariae was produced by L. caperata, including 1176/crushed snail and 726 encysted on the walls of aquaria. Lymnaea palustris and L. catascopium produced fewer metacercariae, with 2014 (403/crushed snail and 243 encysted) and 2256 (260/crushed snail and 457 encysted) total metacercariae, respectively. Lymnaea caperata is an important natural intermediate host in Minnesota, but it is also found outside the endemic fluke range in the state. The L. catascopium used in this study were collected within the endemic fluke range, but there was no evidence that they were involved in natural transmission. Snail habitat and/or deer feeding strategies may determine the roles of known and potential intermediate host species within endemic and non-endemic regions.

A REVISED TAXONOMY FOR TRICHINELLA AND ITS RELEVANCE TO THE EPIDEMIOLOGY OF TRICHINELLOSIS. E. POZIO, G. LA ROSA, INSTITUTO SUPERIORE DI SANITA, ROME, ITALY. K. D. MURRELL* AND J. R. LICHTENFELS, AGRICULTURAL RESEARCH SERVICE, BELTSVILLE, MARYLAND 20705

To try to resolve the controversy surrounding the taxonomy of Trichinella, 152 isolates of Trichinella from a variety of geographic regions and hosts were characterized by extensive allozymic analysis (27 isoenzymes). These data, combined with DNA analysis and biological data such as host range, reproductive capacities in vivo and in vitro, freezing resistance, nurse cell development time and host range isotherm data were subjected to multivariate analysis. The results yielded 8 clusters or gene pools, 5 of which were clearly distinct from all others; the remaining 3 clusters included few isolates and were, therefore, placed in a temporary category (i.e., T-5, T-6 and T-8) until further research can be carried out. The 5 clearly distinct genotypes were designated as T. spiralis (Owen, 1835) sensu stricto, the classical domestic trichinellosis, and four sylvatic species: T. nativa Britov and Boev, 1972, the species commonly seen in Arctic carnivores; T. nelsoni Britov and Boev, 1972 sensu stricto, a wild animal type reported only from equatorial Africa; T. pseudospiralis Garkavi, 1972, the only species with truly unencapsulated muscle larvae and with infectivity for avian hosts; and T. britov sp.n., the predominant sylvatic species in the Palearctic region (Europe, Russia, etc.). The basis for this new taxonomic scheme, and its importance to the epidemiology of this zoonosis will be discussed.
EPIDEMIOLOGY OF PARASITIC GASTROENTERITIS OF SHEEP ON ST. CROIX. C.H. COURTNEY*, UNIVERSITY OF FLORIDA, GAINESVILLE, FL 32611 AND S. WILDEUS, UNIVERSITY OF THE VIRGIN ISLANDS, KINGSHILL, ST. CROIX, VI 00850.

Monthly acquisition of gastrointestinal nematodes by tracer lambs on St. Croix, U.S. Virgin Islands, was followed for 2 years in two flocks of sheep. One was an intensively managed flock and the other, on a similar adjacent pasture, was less intensively managed. Each month 3 tracer lambs were grazed with the ewe flock at each site, then necropsied and gastrointestinal nematodes counted. Fecal egg counts were determined at approximately 2 week intervals in lambs and ewes.

Haemonchus contortus and Trichostrongylus colubriformis were the most abundant nematodes acquired by tracer lambs, with the former worm apparently having the more significant impact on animal health. Most worm transmission occurred from September to March, and the least transmission occurred during the drier summer months. Transmission of H. contortus was best correlated with an index of rainfall in the current and preceding month (r=0.72, p = 0.0001). No correlation was found with any environmental variable (temperature or rainfall) for transmission of T. colubriformis. A modest lactation rise in fecal egg counts was found to occur in ewes.

It is proposed that parasitic gastroenteritis in sheep on St. Croix can be controlled by a combination of strategic treatments to suppress fecal egg output from September to January with supplementary tactical treatments during the remainder of the year whenever a critical rain index value is reached.

CHARACTERIZATION OF IONOPHORE RESISTANCE IN A STRAIN OF E. TENELLA. GUAN ZHU* AND L. R. MCDougALD, DEPARTMENT OF POULTRY SCIENCE, UNIVERSITY OF GEORGIA, ATHENS GA 30602 USA

A field isolate of E. tenella (FS139) was propagated in chickens medicated with 200 ppm of dietary monensin. In laboratory tests with 2-week-old chickens, the strain was resistant to monensin, salinomycin and lasalocid given at 250, 120 or 180 ppm, respectively (2x), and was resistant to narasin and maduramicin at the normal use level (70 or 5 ppm, respectively). Higher lesion scores were produced in medicated birds vs. unmedicated birds (3.6-3.73 vs. 3.0, respectively) and mortality was higher in medicated birds. In comparison, a laboratory strain (WIS) was controlled by the normal use level of each product.

When free sporozoites of E. tenella (WIS) were treated with 1.0 ug/ml of monensin in vitro for 0.5 or 4.0 hr at 41C and inoculated into primary cultures of chicken kidney cells the colonization was reduced by 35.6 or 96.3% but strain FS139 was increased by 18.5 by 1 hr treatment and was about the same as controls after 2 hr treatment. After 4 hr treatment the entry into cells was reduced by 44.4%. Few sporozoites from the WIS strain developed into schizonts, but sporozoites from the FS139 strain developed normally into normal first and second generation schizonts. The morphology of free WIS sporozoites was distorted after 3 hr treatment with 2.5 ug/ml of monensin at 41C, as observed by light and scanning electron microscopy, while there was no change in morphology of treated FS139 sporozoites.

Sporozoites of two isolates of Eimeria tenella (FS 119 and FS 139) that were highly resistant to ionophores and a laboratory strain (WIS) were treated with 100 ug/ml of lasalocid, monensin or salinomycin for 30, 60, and 120 minutes. Flow cytometry and fluorescence microscopy were used to measure differences in reaction with fluorescein diacetate and propidium diacetate, and morphological changes due to drug exposure.

Uptake of FDA and PI by sporozoites changed with time and ionophore exposure, and varied with respect to isolate. Fluorescence of all groups declined by 26% after 60 minutes of incubation, but FS119 and FS139 had overall higher fluorescence (20%) than WIS. Ionophore treated sporozoites fluoresced brighter than untreated controls throughout. Resistant isolates (119 and 139) had higher green fluorescence than WIS after 60 and 120 minutes of treatment with monensin and salinomycin. In contrast, treatment with lasalocid greatly reduced green fluorescence of all strains after 30 minutes. As the cells were killed by drug treatment the granularity ratio (shape) changed and red fluorescence from PI increased. These results demonstrated substantial differences between resistant and susceptible isolates of E. tenella in reaction with FDA, and response to ionophores.

AN UPDATE ON THE ETIOLOGY OF ZOONOTIC VISCERAL AND OCULAR LARVA MIGRANS. K.R. KAZACOS*, PURDUE UNIVERSITY, WEST LAFAYETTE, IN 47907.

Toxocara canis, the dog ascarid, continues to be the most common cause of zoonotic visceral and ocular larva migrans (VLM, OLM); T. cati infection in humans is diagnosed much less frequently. In the last several years, an increasing number of cases of VLM and OLM have been identified in which the etiology is not or does not appear to be Toxocara spp. A review of the literature indicates that there are a large number of other helminths, particularly in wildlife, whose larvae are potential causes of VLM and OLM in humans. Some of these, such as Baylisascaris spp., are well-recognized causes of LM in animals, in which they can be quite pathogenic. The overall frequency of occurrence of these helminths in man would be less than that for T. canis/T. cati; however, they must be considered in the differential diagnosis of human VLM and OLM, especially in particular situations. Potential causes of zoonotic VLM and OLM include other nematodes in the genera Toxocara, Toxascaris, Baylisascaris, Lagochilascaris, Porrocaecum, Ophidascaris, Hexametra, Polydelphis, Travassosascaris, Gnathostoma, and Ancylostoma; the trematodes Alaria and Paragonimus; the cestodes Spirometra and Mesocoeioides; the pentastomes Linguatula, Armillifer, and Porocephalus; and other helminths as yet undefined. The most common findings in cases involving non-Toxocara spp. parasites appear to be negative serology for Toxocara, the presence of "unusual" bands or patterns on Toxocara Western blots, and the presence of ocular larvae clearly larger than Toxocara spp. Illustrative examples will include recently diagnosed cases of Baylisascaris and Alaria larva migrans in humans.
"The zoonotic aspects of giardiasis" Gaétan M. Faubert*, Institute of Parasitology, Macdonald Campus of McGill University, 21111 Lakeshore Bvld., Ste. Anne de Bellevue, Québec, H9X 1C0.

For many years, *Giardia lamblia (intestinalis)* has been considered host specific. In recent years, several observations in the laboratory have shown that cysts from human sources can infect laboratory and domestic animals. In fact, *Giardia* cysts from humans can be infective to guinea pigs, dogs, beavers, raccoons and bighorn sheep. Giardiasis in companion and farm animals is common worldwide. Unfortunately, the relevant publications describing the disease in these animals present rudimentary evidence that the domestic and/or companion animals had been infected with a *Giardia* species that could be infective to humans.

Zoonoses can be defined as: "diseases and infections which are naturally transmitted between vertebrate animals and man". Diseases transmitted by the faecal-oral route, as is the case for giardiasis, are less easy to classify as zoonoses, because it is necessary to demonstrate that the causative organism infects both man and other animals and that it can be transmitted between them.

This paper will review our present knowledge of the incidence of the infection in farm and companion animals and the role that wild animals play as reservoirs of the disease. Has giardiasis been reported among individuals engaged in the handling of infected animals? Is it possible that *Giardia* is not only a zoonose but a zooanthroponose as well?

STUDIES IN BRAZIL TO DETERMINE IF THE DOG IS AN IMPORTANT ANIMAL RESERVOIR FOR HUMAN VISCERAL LEISHMANIASIS. J.R. DAVID1,4*, D.A. ASHFORD1, C. EULALIO3, M. FREIRE3, C. MIRANDA4, M.G. ZALIS1, AND R. BADAR62,3. HARVARD SCHOOL OF PUBLIC HEALTH, CORNELL UNIVERSITY MEDICAL COLLEGE, UNIVERSIDADE FEDERAL DA BAHIA, AND FUNDACAO OSVALDO CRUZ-BAHIA, BRAZIL.

Although canine visceral leishmaniasis is widespread throughout the world, the role of the dog as an important reservoir for human leishmaniasis has not been firmly established in the western hemisphere. To evaluate the role of infected dogs in the transmission of visceral leishmaniasis to humans, we initiated a controlled intervention project in Brazil to determine whether the removal of infected dogs effects the incidence of human cases. For this purpose, we have adapted the FAST-ELISA which can detect positive serology, using whole blood, in twenty minutes under field conditions. The FAST-ELISA was shown to have a sensitivity of 88% and specificity of 90% similar to the standard ELISA and more sensitive than the IFA. Starting in 1989, dogs were surveyed twice a year in the intervention area (III & IV) of a town and the seropositive dogs were eliminated. In another area (I) of the town across a river and 4 km away, dogs were surveyed once a year and none were eliminated. By 1991, the prevalence of positive dogs in area III & IV had decreased from 35% to 10% and the animal incidence diminished from 20% to 5%. In area I the prevalence was essentially unchanged, from 24% to 28%. We are presently assessing the number of human cases in each area as well as determining human sero-conversion to evaluate whether or not the significant decrease in the prevalence of infected dogs had any beneficial effect on humans.
Loishmaniasis is a vector-borne, zoonotic disease caused by any of several species of protozoan parasites. Despite Leishmania's tropical distribution, infections in four Foxhounds in a kennel in Michigan were confirmed by histopathology or culture during 1989 or 1991; these four dogs had never been out of the state of Michigan. Clinical findings of the infected dogs include weight loss and lymphadenopathy. During this three year period, an additional 16 (15.5%) of 103 dogs in this kennel have been found to be seropositive for Leishmania (indirect immunofluorescent assay ≥1:32). None of 61 dogs at two similar kennels in Michigan had a titer that indicated recent infection. Serologic screening of 9 employees of the affected kennel was negative in 8 and borderline positive in 1. Behavior of the organism in culture and enzyme isotype patterns of the Michigan canine isolate were dissimilar to WHO reference strains known to infect dogs or humans. The mode of transmission and the infecting species of Leishmania are currently unknown.


A previous report gave the prevalence rates for endoparasites of dogs and cats seen at our teaching hospital for the years 1983-1986 (Kirkpatrick, 1986, Vet. Parasitol. 30:113). This report covers the years of the original report and extends it through 1991. Of 8077 canine fecal samples examined by the zinc sulfate floatation technique, 28.3% were found to contain one or more parasites. Over the 8 year period, hookworms and whipworms were the most common parasites of dogs (10% and 9.6% of the samples, respectively). Ascarids (5.3%), Giardia (4.5%), coccidia (3.3%) and tapeworms (1.6%) were often found. Heartworm prevalence for these 8 years, as determined by the Knott's test or serology, was 2.5%. Of 2000 feline fecal samples examined, 25.7% contained one or more parasites. Ascarids were the most common parasites, being found in 16.2% of the samples examined. Other parasites often found in felines were coccidia (4.7%), tapeworms (3.6%), Giardia (2.7%), and hookworms (1.0%). Many of the canine parasites were more prevalent during the early part of this study then at the end of the study period. The trends in parasite prevalence will be presented for both cats and dogs.
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**DIROFILARIA IMMITIS IN DOGS IN BRITISH COLUMBIA, CANADA: FIRST RECOGNIZED AUTOCHTHONOUS CASE AND A PRACTITIONER-BASED SURVEY OF TESTING AND FREQUENCY.** L. POLLEY, G. MACKENZIE, B. WAGNER AND P. HAUGEN. VETERINARY MICROBIOLOGY, UNIVERSITY OF SASKATCHEWAN, SASKATOON, CANADA S7N 0W0.

In March, 1991, heavy *Dirofilaria immitis* infection (329 adult parasites in the heart) was diagnosed at necropsy following acute illness in a hound in Oliver, B.C. The hound had never left the south Okanagan Valley area. In July 1991, a mail survey of all small animal and mixed practice veterinary clinics in British Columbia was initiated to gather data on heartworm for the period 1 January to 31 December 1991. The overall response rate to the survey was 69% (200/289) and in the Okanagan Valley area 89% (31/35). Over the survey period, a total of at least 25,362 dogs were tested for *D. immitis*. A total of 55 cases were detected, 53 of which were in the Okanagan Valley area, where it is believed that 45 of the cases acquired the infection. Travel histories of the other 10 infected dogs were either unknown or included travel to endemic areas.

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**HEARTWORM IN MINNESOTA - REFLECTION ON THE PAST TEN YEARS.** B.E. STROMBERG, S.M. PROUTY, G.A. AVERBECK AND J.C. SCHLOTTHAUER. UNIVERSITY OF MINNESOTA, ST. PAUL, MN 55108

Heartworm (*Dirofilaria immitis*) infection has been enzootic in dogs in Minnesota since 1939. Initially the enzootic area was in the Twin Cities metropolitan area and has subsequently spread outward throughout the state. This spread has been monitored by alternate year surveys of practicing veterinarians. The most recent was for the calendar year 1990.

The number of cases of heartworm reported has continued to fall since 1984. This past year 588 of the 167,293 dogs tested were positive for a prevalence of 0.35%. However, the infection with *Dirofilaria immitis* continues to spread throughout the state and is now considered to be enzootic in 72 of the 87 counties in the state. Prevalence continues to fall and this is presumed due to the wide spread acceptance and use of highly efficient preventative medications; reduced rainfall with subsequent reductions in resident mosquito populations; and the effective mosquito control programs. This survey is biased in that it surveyed practitioners who are examining and treating dogs which are for the most part well cared for. The true prevalence will not be known until a pound dog study is conducted. Three cases of heartworm in cats were reported as well as 12 cases of *Dipetalonema reconditum*. 
A NEW SPECIES OF *MEGATRYPANUM* FROM A RUSSIAN PALLAS CAT *FELIS MANUL* ALSO INFECTED WITH *HEPATOZOOON* AND FELINE IMMUNODEFICIENCY VIRUS. S.C. BARR*, D.D. BOWMAN, AND L. PHILLIPS. CORNELL UNIVERSITY. ITHACA, NY 14850.

During a health screen of a Pallas cat (*Felis manul*) imported from the Moscow Zoo to the Brookfield Zoo, Chicago, in September, 1990, a trypanosome was seen in a Wrights stained blood smear. The cat had previously been wild caught in Kazakhstan, (previously) USSR. The cat was also infected with a *Hepatozoon* sp. and feline immunodeficiency virus. Specimens measured in blood smears in October 1990 had total body length including the free flagellum, 23.1 ± 2.3 (18 - 28); posterior extremity to nucleus (PN), 9.2 ± 1.0 (7 - 12); nucleus to anterior extremity (NA), 11.5 ± 2.2 (7 - 16); kinetoplast to nucleus (KN), 3.9 ± 0.9 (3 - 7); posterior extremity to kinetoplast (PK), 5.3 ± 0.7 (4 - 6); kinetoplast index (PN/KN), 2.4 ± 0.3 (1.6 - 3.1); nucleus index (PN/NA), 0.8 ± 0.2 (0.6 - 1.4); free flagellum (F), 2.4 ± 0.9 (1.1 - 3.8). The body was drawn out to a point at the posterior end and more often "S" shaped. No dividing forms were observed. The *Megatrypanum* did not grow well in conventional media, but co-culture with African green monkey kidney cells in Eagle’s MEM at approximately 27° C resulted in luxuriant growth of trypanosomes. Under these growth conditions, epimastigotes adhered to the surface of the culture flask and African green monkey kidney cells, as well as formed large rosettes. Some epimastigotes could be seen with scanning electron microscopy dividing by binary division. A feature of all the epimastigotes was a cup-like depression at the terminal end of the free flagellum. No intracellular parasites were seen at room temperature or 37° C. At 37° C, although growth was poor, transformation of the epimastigotes into the bloodstream forms occurred. This represents the first report of a trypanosome of the subgenus *Megatrypanum* in a felidae.

CONTINUED STUDIES ON CYSTIC ECHINOCOCCOSIS IN THE XINJIANG/UYGUR AUTONOMOUS REGION, PRC. F.L. ANDERSEN*, R. MING, AND H.D. TOLLEY, BRIGHAM YOUNG UNIVERSITY, PROVO, UT 84602; AND J. CHAI AND F. LIU. NATIONAL HYDATID DISEASE CENTER OF CHINA, URMQI, XINJIANG, PRC.

Continued cooperative studies in the Xinjiang/Uygur Autonomous Region (XUAR), PRC, now focus on the development of computer-assisted surveillance methods, frequency distribution studies on *Echinococcus granulosus* in dog and sheep populations, use of transmission predictive modeling schemes, and assemblage of a compendium of articles on cystic echinococcosis. The latter will detail all surveillance studies for *E. granulosus* done in dogs and in intermediate hosts (principally sheep), and all surgical cases recorded for XUAR inhabitants. Analyses indicate that infection pressure in dogs was 0.4560 infections/yr and the mean length of an infection was 1.4975 years. Dogs obviously have ready access to infected sheep viscera. In female sheep the infection pressure was 0.4362 and the mean number of cysts increased linearly by 0.8824/yr. Thus, acquired immunity did not have a significant impact on prevalence of the parasite in those hosts. Further analyses indicate that since the parasite may still be in an endemic steady state, continued praziquantel treatment of dogs could aid significantly in efforts to decrease infection levels.

During the summer of 1991, approximately 85 emu chicks, Dromiceius novaehollandiae, 2 to 5 months of age developed central nervous signs of torticollis, ataxia and abnormal gait. Eventually the condition lead to recumbency and death. A filarid nematode was found in histologic sections of the brain and spinal cord.

Immature adult Chandlerella quiscali were dissected from the cervical spinal cord, brain and/or lateral ventricles. None of the affected birds developed microfilaremia. Several birds with mild signs were observed over a six month period. They stabilized, but no microfilaria were found at any time in these birds. Collections of Culicoides, vectors of Chandlerella, were made at one of the farms with affected birds. In addition, several common Quiscalus quiscula, and great tailed Q. mexicanus, grackles were collected and large numbers of C. quiscali were recovered from the lateral ventricles of these birds. No older emus on the farms developed signs of disease or a microfilaremia.

A TAXONOMICAL RESEARCH ON HELMINTHS OF NON-AQUATIC BIRDS. M.R. SIAVASHI*, J. MASOUD. TEHRAN UNIVERSITY OF MEDICAL SCIENCES, TEHRAN-IRAN, P.O. BOX 6446-14155.

Different organs of 36 birds of different kinds including: Columba livia, Streptopelia turtur, Passer domesticus, Luscinia megarlynchos, Francolinns francolinus, Vanellus vanellus were searched to find helminths.

The helminths which are reported for the first time in Iran by this research are as follows:


Morphological aspects of helminths were the base for diagnosis of each helminth.

Two groups of 6 pony mares and their foals were maintained on two separated pastures. One group of mares received ivermectin prior to foaling and turn out, followed by daily Strongid-C supplemented feed supplied to mares and foals. The second group received no anthelmintic treatment. A third group of 6 foals were reared in a parasite free (PF) environment and received no anthelmintic treatment. Following weaning, and exposure to a contaminated pasture (4 wks), half of the pasture reared foals were challenged with 1,000 S. vulgaris L₉, 5,000 S. edentatus L₉, and 100,000 mixed small strongyle L₉. The PF foals were not exposed to the contaminated weaning pasture prior to challenge. Foals were necropsied 6 wks post-challenge. Based on clinical signs recoveries of larval strongyles, and lesion development, foals reared without the benefit of anthelmintic treatment showed signs of protective resistance to challenge and Strongid-C reared foals did not. Details of worm recovery data, pathology and some immunologic parameters will be presented. (Supported in part by Pfizer, Inc.).

STRATEGIC CONTROL OF STRONGYLES WITHIVERMECTIN IN YEARLING PONIES IN ONTARIO. OWEN SLOCOMBE* AND MARY C. LAKE, DEPARTMENT OF PATHOLOGY, ONTARIO VETERINARY COLLEGE, UNIVERSITY OF GUELPH, GUELPH, ONTARIO N1G 2N1

In May 1990, 19 yearlings, naturally infected with strongyles and without previous anthelmintic treatment, were allocated to 2 groups. Ponies in one group were given ivermectin at 200ug/kg body weight orally on May 8, July 3, August 25 and November 20. Each group was placed on a separate pasture from May 10 to November 21 and then housed overwinter. Every 2 weeks from May through April 1991, a fecal sample was taken from each pony and from May to November herbage samples from each pasture. Ponies were weighed monthly. In May 1991, 2 yearlings from each group were necropsied. A tracer foal with its dam, which was kept epg negative by anthelmintic treatment, was placed on each pasture on two occasions; a 4-week old foal from July 4-September 4; a 6-week old foal from September 7-November 20. After removal from pasture, foals were weaned, isolated indoors for 2 months and necropsied.

Prior to treatment on May 8, mean strongyle epgs in both yearling groups were above 1100. Mean epg for untreated ponies increased to 2105 in mid-July and then declined. Mean epg for treated ponies was at or about zero except in early July when it was 183 and from February 1991 onwards. At peak pasture contamination in late summer, about 60,000 strongyle larvae/kg dry herbage were recovered from the pasture with untreated ponies; 3949 from the other pasture. Mean weights (kg) at start and end of the pasture season for treated ponies were 116 and 180; for the untreated, 120 and 165. At necropsy, 2 treated yearlings had 7138 and 9580 strongyles in the large intestine; the 2 untreated had 30,132 and 83,320. Two foals on pasture with treated ponies had no Strongylus vulgaris in the ileocolic arteries and 1512 and 960 strongyles in the large intestine and at the earlier and later time periods respectively; 2 foals on the other pasture had 2 and 17 S. vulgaris and 3596 and 23,472 strongyles. The spring-summer anthelmintic strategy appeared to significantly reduce transmission of strongyles and cause an increase in weight gain in treated yearlings.
THE EFFECT OF DAILY ADMINISTRATION OF PYRANTEL TARTRATE ON THE DEVELOPMENT AND LARVAL MIGRATION OF EXPERIMENTALLY INDUCED INFECTIONS OF PARASCARIS EQUORUM IN PONY FOALS. K.M.EWERT*, J.A.DIPIETRO1,R.SANECKI1,D.J.WALSTROM2,K.S.TODD1. UNIVERSITY OF ILLINOIS, URBANA, IL 61801, 2PFIZER INC., LEES SUMMIT, MO 64081.

Fourteen pony mares and their foals were individually maintained in concrete stalls. Each mare and her foal were allocated to replicates based on the date of foaling (Day 0). Group 1 mares and foals served as untreated controls. Treatment of group 2 mares and foals with pyrantel tartrate (2.64 mg/kg) was done daily from Day 0 through Day 31. All foals were inoculated with approximately 1500 infective $P_{equorum}$ eggs on Days 7, 14, 21, and 28. Fecal examinations were performed weekly on mares and foals. On Day 32, the foals were euthanized, necropsied, and examined for intestinal, hepatic, and lung stages of $P_{equorum}$. All intestinal larvae recovered were enumerated and identified to stage. Lung and liver tissue was examined for the presence of $P_{equorum}$ larvae and scored for pathological changes.

One foal was detected passing one embryonated ascarid egg on Day 7. The mean number of fourth-stage larvae recovered from the small intestine of control and treated foals was 786 and 4.4, respectively. Larvae were present in 100% of the lungs and 43% of the livers in control foals, and 57% of the lungs and 14% of the livers in treated foals. In control foals, the mean number of gross lesions in the liver and lung was 24.7 and 11.7, respectively. Treated foals had a mean of 5.9 lesions in the liver and 6 lesions in the lung.

DURATION OF EFFICACY FOR VARIOUS ANTHELMINTICS USED TO CONTROL PARASITES IN THE YOUNG HORSE. J. KIVIPELTO* AND R.L. ASQUITH. UNIVERSITY OF FLORIDA, GAINESVILLE, FL 32611.

Young horses host the most ubiquitous of all equine parasites, the small strongyle, as well as some parasites not ordinarily found in the adult horse, such as Parascaris equorum and Strongyloides westeri. Controlling infection by these parasites involves the therapeutic use of anthelmintics which are designed to eliminate parasites existing in the horse, thus reducing the number of parasite eggs passed into the horse's environment. The longer this period of reduced egg output after anthelmintic treatment, the more effective that treatment is. A total of 82 young horses, 4 to 13 months of age, were utilized for 8 different anthelmintic compounds. The period of efficacy following treatment with ivermectin, febendazole, piperazine, pyrantel pamoate, febantel, cambendazole, piperazine/carbon disulfide/phenothiazine and trichlorfon/phenothiazine/piperazine was evaluated by weekly egg per gram counts (EPGs) obtained after treatment. While pretreatment EPGs averaged 1,345 per animals, these EPGs were reduced to 0 for up to 8 weeks after treatment in the ivermectin treated animals. Piperazine reduced EPGs to 0 for 1 to 2 weeks following treatment while the average EPG actually increased in 17 foals following treatment with febendazole. While the other 5 anthelmintic compounds tested reduced the EPGs within 1 week posttreatment, these EPGs were never reduced to 0. Ivermectin was the most effective anthelmintic in duration of efficacy when tested against 3 major parasite groups affecting young horses.
EFFICACY OF MOXIDECTIN AGAINST EQUINE PARASITES. T.R. BELLO*,
J.E.T. LANINGHAM AND RUDI AGUILAR. SANDHILL EQUINE CENTER,
SOUTHERN PINES, NC 28387; PINEHURST PATHOLOGY INC., PINEHURST, NC
28374 AND AMERICAN CYANAMID COMPANY, PRINCETON, NJ 08543-0400.

Four groups of 10 ponies were used in a controlled trial to evalu­
ate treatment with moxidectin against naturally-acquired para-
site infections. Vehicle or moxidectin oral gel was given at
0.3, 0.4, or 0.5 mg/kg dosage rate, with necropsy examination 14
days later. Efficacy against Gasterophilus intestinalis was
based on dosages of 0.3 (94.5%), 0.4 and 0.5 mg/kg (97.8%).
Onchocerca cervicalis MF were 100% removed by all dosages. Ano­
plocephala perfoliata or A. magna were not removed. Strongylus
vulgaris, S. edentatus, small strongyle, Habronema muscae adults
and immatures and Oxyuris immatures in the lumen were removed
99.9 to 100% by all dosage rates. Strongyle EPG counts and
larvae cultures reflected these effects. Small strongyle larvae
coiled within cecal and colonic mucosa were 92.4% removed, and
larvae within mucosal nodules were 74.9% removed.

All vehicle controls had inflamed, edematous and generalized
irritation of intestinal mucosa. In each of the treated groups,
7/10 ponies had nodular and moderately reactive tracts, 3/10 had
smooth and nonreactive mucosa without edema. (Supported in part
by American Cyanamid Co.)

DOSE TITRATION STUDY OF MOXIDECTIN GEL AS AN ORAL EQUINE
ANTHELMINTIC. C. R. REINEMEYER, R. AGUILAR. UNIVERSITY OF
TENNESSEE, KNOXVILLE, TN 37996, AND AMERICAN CYANAMID COMPANY.

This study was designed to determine the dosage of moxidectin gel with optimal efficacy
in horses against natural infections of ascarids, bots, pinworms, and large and small
strongyles. Forty yearling horses were assigned to 10 replicates based on similarities of
fecal egg counts and strongylid larval cultures. Within each replicate, horses were
assigned randomly to one of four treatment groups: control (placebo), or oral moxidectin
gel at 300, 400, or 500 µg/kg body weight. Study parameters included fecal egg counts
and larval cultures; necropsies and worm counts were performed 14 days after treatment.

Moxidectin at 300, 400 or 500 µg/kg removed 84.6%, 100% and 99.4% of Strongylus
vulgaris and 96.1%, 99.1%, and 99.6% of Strongylus edentatus from the gut lumen;
36.4%, 93.9%, and 100% of S. edentatus larvae from the peritoneum; 100%, 99.8%, and
99.9% of Oxyuris equi; and 82.4%, 87.7%, and 92.6% of Gastrophilus spp., respectively.
At least 98.6% of total cyathostomes in the lumen and 100% of Parascaris equorum,
Trichostrongylus axei, and Habronema muscae were removed at all dosages. Parascaris
equorum and strongylid fecal egg counts were reduced at 14 days after treatment by 100%
and >99.9%, respectively, by all dosages of moxidectin. The efficacy of moxidectin
against larval stages of S. vulgaris in the mesenteric arteries and against encysted
cyathostome larvae in the gut wall was inconsistent and apparently not related to dose.

No signs of toxicity accompanied treatment of horses with moxidectin at up to 500 µg/kg.
EFFICACY OF MOXIDECTIN GEL IN EQUIDS. J. A. DiPietro*, A. J. Paul, T. F. Lock, K. M. Ewert, K. S. Todd, Jr., and R. Aguilar†, Departments of Veterinary Pathobiology and Clinical Medicine, College of Veterinary Medicine, University of Illinois, Urbana, IL 61801 and †American Cyanamid Company, Princeton, NJ 08543-0400.

A controlled trial was carried out to evaluate the efficacy of 0 (controls), 300, 400, and 500 μg of moxidectin (MXN) /kg as a gel administered orally (on day 0) against naturally acquired parasite infections in 40 equids. On day 0 geometric mean strongyle egg per gram counts (EPG), P. equorum EPG, and larval cultures including both large and small strongyles were similar for all treatment groups. On days 7 and 14 geometric mean strongyle EPG and P. equorum EPG were 0 for all horses treated with MXN while those for controls ranged from 5-1435. Animals treated with MXN in all cases except 1 were not detected passing large or small strongyle larvae on days 7 and 14. Total mean number of large strongyles recovered from control animals on day 14 was 142. Mean numbers of large strongyles ranged from >1 to 35. Treatment with 300, 400, or 500 μg of MXN /kg was 100% effective against large strongyles. Small strongyles were recovered from all animals in the control group. Total mean number of small strongyles recovered from the controls was 27,157. Efficacy of 300 and 400 μg of MXN /kg against 4th-stage Cylicocyclycus larvae, Cyathostomum catinatum, and Cyclicostephanus minutus ranged from 97.1 to 99.5%. Efficacies against all other small strongyles was 100% with all levels of MXN. Efficacy of 300, 400, and 500 μg of MXN /kg against small strongyles as determined by total small strongyle burdens was 99.8, 99.9 and 100% respectively. Efficacy of MXN against Gasterophilus intestinalis was 61.6, 95.3, and 93.1% respectively for animals treated with 300, 400, and 500 μg of MXN /kg. Efficacy of MXN against adult P. equorum was 100%. Efficacy against Habronema muscae and H. majus was greater than 98% for all treatment levels of MXN. Efficacy against Anoplocephala spp was inconsistent (37.7-100%). Off color, autolyzed, non-viable S. edentatus larvae were recovered from 20, 30, and 10% of the 300, 400, and 500 μg of MXN /kg treatment groups respectively. Visible S. edentatus larvae were recovered from 10% of the control animals. S. edentatus subserosal hemorrhages were more common in MXN treated animals. S. vulgaris larvae were recovered from arteries of 30, 10, 30, and 20% of the 0 (control), 300, 400, and 500 μg of MXN /kg treatment groups respectively. Efficacy of MXN against mural cyathostome larvae as determined by mural transillumination or digest was 58.9-71.7, 95.2-85.1, and 91.7-78.0% for animals treated with 300, 400, and 500 μg of MXN /kg respectively. Adverse reaction due to treatment with MXN gel or vehicle was not observed.


Forty mixed-breed ponies were used in a controlled test to evaluate the efficacy of moxidectin at 300, 400, and 500 mcg/kg of body weight. Treatment groups contained 10 replicates of 4 ponies each and each replicate was housed separately on concrete slabs. Full thickness 6 mm skin biopsies were taken from the ventral midline of each pony prior to treatment and at necropsy for enumeration of Onchocerca cervicalis microfilariae. All doses of moxidectin were 100% efficacious against adult Strongylus vulgaris and S. edentatus and had high (95-100%) efficacy against larvae of S. vulgaris and S. edentatus. Moxidectin was also highly efficacious (>95%) in removing luminal fourth stage and adult cyathostomes, Habronema muscae, Trichostrongylus axei, Parascaris equorum and Oxyuris equi. Moxidectin also appears to be effective against mucosal cyathostome larvae as determined by transillumination (78-84%) and digestion (84-92%) techniques. Variation in efficacy against these was not dose related. All doses were 100% effective in removing O. cervicalis microfilariae. Moxidectin at 300 mcg/kg was only 78% effective against Gasterophilus intestinalis larvae but was 100% efficacious at higher dosages.

The efficacy of 3 dose levels of moxidectin (300, 400 and 500 mcg/kg) were tested against experimentally induced infections of Strongylus vulgaris and Parascaris equorum in a controlled study. Six animals were used per treatment group. At the time of treatment S. vulgaris infections were 8 wks old and P. equorum infections were 11 days old. Based on viable arterial larval recoveries, efficacies against S. vulgaris were 99%, 100%, and 100% at 300, 400 and 500 mcg/kg respectively. The numbers of P. equorum which established in the intestines of untreated controls was unusually low (5.8±4.8). None-the-less efficacy of all dose levels against this parasite was 100%.

A NOVEL SCREENING METHOD FOR DETECTION OF FLUKICIDAL ACTIVITY
M. E. DOSCHER*, AMERICAN CYANAMID COMPANY, PRINCTON, NJ

A novel method for detecting flukicidal activity has been developed using free-living flatworms. Fasted fresh-water planaria, Dugesia tigrina or Phagocata morgani, are fed on livers either fresh or frozen removed from gerbils which have been treated with test compounds. The worms are then observed for 4-5 days and their behavior compared to controls fed on liver from untreated gerbils. Activity may be shown by excitation, writhing, death, partial disintegration, or loss of body contents depending on the species and compound used. Experimental compounds may be administered to gerbils by diet, gavage or injection.

Known flukicidal compounds such as albendazole, luxabendazole, thiabendazole, oxyclozanide and niclosamide have shown activity in this assay while such anthelmintics as levamisole, ivermectin and morantel have been inactive. Albendazole in particular is highly active against both planaria species whether administered in the diet or by single oral dose.

This screen can be conducted in conjunction with a gerbil/Trichostrongylus colubriformis assay for nematode activity.
PARABAN, A MODEL FOR EVALUATING ANTHELMINTIC STRATEGIES AGAINST COMMON TRICHOSTRONGYLID INFECTIONS OF CATTLE.
G. SMITH. DEPARTMENT OF CLINICAL STUDIES, NEW BOLTON CENTER, SCHOOL OF VETERINARY MEDICINE, UNIVERSITY OF PENNSYLVANIA. 382 WEST STREET ROAD. KENNETT SQUARE, PA 19348; AND J. GUERRERO. MSD AGVET, DIVISION OF MERCK & CO. BOX 2000. RAHWAY, NJ.

The population biology of the common trichostrongylid gastrointestinal nematode parasites of cattle is very similar from one species to the next. Thus, a single model for the processes that regulate and control parasite abundance can be used as the structural basis for evaluating disease control strategies against many of the representatives of this economically important family of parasites. PARABAN is such a model. This presentation will review the trickle- and single-infection experiments that underpin the claim that the trichostrongylid population biology can indeed be represented by a single model and compare PARABAN output with field trial data from Europe and the Americas.

A GENTLEPERSON'S GUIDE TO PRACTICAL FLEAKEEPING. J.R. GEORGI* AND M.E. GEORGI. FLEADATA, INC., 132 STARR STANTON RD., FREEVILLE, NY 13068-9631.

Ctenocephalides felis adults were fed warmed (38C) whole bovine blood through Parafilm membranes using the Artificial Dog. Mortality of 28 female and 5 male artificially fed fleas was not observed among females until after day 13 and among males until after day 22. At the end of 25 days, 10 females but no males remained. A total of 4006 eggs were produced and these yielded 2443 larvae, 2274 pupae, and 2040 adults. At peak production during the first week, females produced a mass of eggs (no. of eggs x 22 g/egg) about equal to one-third of their body weight and passed a mass of feces equal to 6 times their body weight. A decline in fecal output was observed after the second week paralleling the decline in egg output.

Twenty cages, each containing 200-300 fleas, have produced an average of 10,000 adult fleas per day for over a year, thus demonstrating the suitability of the Artificial Dog for mass production of fleas required for experimental purposes. Other applications include assay of insecticides and insect hormones, investigation of adult flea physiology, and harvest of flea saliva for immunologic investigation.

Cyclops are predators which feed upon algae, protozoa, bacteria, and other microinvertebrates found in pond water. Among other uses, they serve as intermediate hosts in the transmission process of dracunculiasis. Immunological investigation of dracunculiasis, particularly the early phase, requires infective guineaworm larvae be available in reasonable quantity for experimentation. Because only a single guineaworm larva may establish in each cyclop, harvesting of large numbers of infective parasite larvae requires mass culture of the intermediate host species. Growth of cyclops under laboratory conditions, requires establishment of particularly rich infusion media capable of supporting high densities of the prey species. A medium based on fresh cow manure and aged tap water has been found to enhance the initiation of cyclops cultures and to support cyclops populations of a greater density than hay infusion, the conventional medium for growing copepods. Supported by a grant from the Conservation, Food and Health Foundation.


Eperythrozoon suis is the causative agent of swine erythrozoonosis. Successful in vitro culture of the agent would greatly facilitate research on E. suis by eliminating the need of using splenectomized pigs to propagate the organisms. In previous studies, preliminary screening of culture environments was done and Eagle's medium was found to be the most suitable for E. suis culture.

In the present study, the effect of various treatments on E. suis viability in vitro were further analyzed: 1) addition of inosine, which is an energy source of swine RBC; 2) addition of EDTA which kills E. suis; 3) incubation under different gaseous environments; 4) incubation with different types of serum; and 5) refreshment of culture media. The criteria used to evaluate E. suis viability in culture were: 1) change in the percentage of parasitized cells during culture; and 2) glucose concentration in culture media.

The results indicated that swine RBC integrity was improved by the addition of inosine to culture media. However, no effect was observed on E. suis viability. Glucose was consumed by E. suis itself rather than by infected RBC's because glucose consumption was not observed in infected RBC's after killing of E. suis by EDTA. No difference in E. suis viability was observed with in a 5% CO2 incubator or a candle jar. Glucose consumption by E. suis was significantly increased by addition of fetal calf serum to medium. Parasitism of E. suis on RBC's and glucose consumption was improved by refreshment of media.
EXPERIMENTALLY INDUCED PROLIFERATIVE GILL DISEASE (PGD) IN CATFISH AFTER EXPOSURE TO A MYXOZOAN PARASITE. L. M. POTÉ*, T.L. LIN, E. F. CHENNEY AND J. A. HACKATHORN. COLLEGE OF VETERINARY MEDICINE, MISSISSIPPI STATE UNIVERSITY, MISSISSIPPI STATE, MS  39762.

Proliferative gill disease (PGD) is responsible for significant mortalities in channel catfish. This disease is characterized by the consistent presence of myxozoan-like parasite in the gills of catfish. The life cycle of this organism has not been elucidated, however, outbreaks of this disease have been correlated with the presence of the annelid, *Dero* sp. infected with myxozoa, in pond sediment. This study examined the role of myxozoa in the PGD life cycle.

Specific pathogen free (SPF) channel catfish were divided into 4 groups (n=10), each group was housed in a 5 gallon aquarium. One group was the negative control, another group were exposed to squashed *Dero* sp (n=20) infected with tryactinomyxid myxozoa, a third group was exposed to live infected *Dero* sp (n=20) housed in a flow-through container, which allowed the escape of the myxozoa into the aquarium and the fourth group was directly exposed to myxozoa for the first 6 hours. Fish were necropsied on day 7 post-exposure and gills were collected for histology. Histological examination of the gills revealed that 100% of fish directly exposed to myxozoa were infected; 20% of the fish exposed to live infected worms were infected and the remaining groups were uninfected. In a second experiment SPF fish were exposed to myxozoa on day 1 or daily for 8 consecutive days. On day 8 all fish were necropsied. Histology showed the presence of PGD organisms in the gills in 90% of the fish exposed to myxozoa on day 1, while 70% of the gills were infected in fish exposed to myxozoa daily for 8 days. This research confirmed myxozoa are involved in the PGD life cycle.


Although *Giardia* is a common parasite of dogs, few experimental studies of infection have been performed. To compare diagnostic techniques and evaluate effects of infection on canine intestinal function, 9 *Giardia* free, 6-month-old dogs from 2 litters received 10,000 *Giardia* cysts isolated from the feces of a naturally infected dog. Four other littermates were uninfected. Fecal samples were examined by zinc sulfate flotation daily until patency and then every other day until infection was no longer detectable. Selected samples were also examined by a fecal ELISA test (ProSpecT, Alexon, Inc.). Duodenal aspirates were collected weekly for 8 weeks following infection and then monthly to the end of the study. Intestinal function was measured by D-xylose absorption test, serum Vitamin B-12 and trypsin like immunoreactivity (TLI) levels and levels of split and unsplit fecal fats.

None of the infected dogs developed diarrhea and indicators of intestinal function remained within normal ranges, although some elevation in split fecal fats was seen in infected dogs for 4 weeks after infection. Differences were seen in duration of cyst shedding and cyst numbers between the 2 litters of dogs. *Giardia* cysts were present in feces of individual dogs for 30 to 230 days after infection. Comparison of diagnostic tests showed that 3 fecal exams were superior to duodenal aspirates in diagnosis of infection and that the fecal ELISA yielded results similar to flotation exam.
EXPERIMENTAL BOVINE NEMATODIRIASIS: STUDIES ON THE RESPONSE OF CALVES TO MODERATE TO HIGH LEVELS OF EXPOSURE. D.E. WORLEY AND F.M. SEESEE, VETERINARY MOLECULAR BIOLOGY LABORATORY, MONTANA STATE UNIVERSITY, BOZEMAN, MT 59717; E.O. DICKINSON*, PROFESSOR EMERITUS, DEPARTMENT OF VETERINARY SCIENCES, UNIVERSITY OF NEBRASKA, LINCOLN, NE 68583.

The course of experimental *Nematodirus helvetianus* infections and their effect on growth rate and certain physiologic parameters in parasite-naive Holstein calves were investigated to complement previous data in which single doses of 5,000 - 25,000 larvae were used. Current studies with inocula of 40,000 and 80,000 larvae were evaluated with reference to calf performance via weekly fecal egg counts, body weights, and selected hematologic and serum biochemical values. Parasite egg production induced by either level of inoculation was transient, resulting in self-limiting patent infections or non-patency. Peak egg counts averaged 48 and 28 eggs per gram of feces at dose levels of 40,000 and 80,000, respectively. These egg output rates were 84 - 92% lower than those induced previously with doses of 10,000 or 25,000 larvae. Calf growth was suppressed during the first 4 - 6 weeks postinoculation at the 80,000 dose level but not at the 40,000 dose level. After approximately 8 weeks, average daily weight gains equalized in calves given 40,000 larvae and their nonparasitized controls. Long term growth rates in uninoculated calves averaged 1.51 lb./day vs. 1.14 lb. in low-dose calves and 1.16 lb. in high-dose animals. The calculated weight gain advantage in nonparasitized calves was 22.5 - 24.5% during a five-month period postinoculation. No significant changes in hematologic or serum biochemical values occurred at either level of exposure.

TOWARDS A BETTER MEETING: THE VISUAL PRESENTATION OF PARASITOLOGICAL GRAPHS AND TABLES. J. WILLIAMS, K. KAZACOS AND G. ZIMMERMAN. DEPARTMENT OF MICROBIOLOGY AND PUBLIC HEALTH, MICHIGAN STATE UNIVERSITY; VETERINARY PATHOBIOLOGY, PURDUE UNIVERSITY; AND COLLEGE OF VETERINARY MEDICINE, OREGON STATE UNIVERSITY.

An array of contemporary devices can be used to create projection slides of sparkling quality, yet the readability and attractiveness of most transparencies shown at scientific meetings, including ours, has not improved noticeably, on average. Those who made good slides for their presentations using older methods now make even better ones using computerized graphics and harmonized color schemes. But most of us do not create eye-catching displays of data, exquisitely proportioned and clearly visible to the back-row haggler. Some of the modern means of achieving these goals will be illustrated, and some examples the finest—and usually the simplest—, and of the worst—and usually the most complex—, will be displayed. The aim is to heighten our society's appreciation of the value of good projection slides, and to enhance the quality of AAVP presentations.
Title: Safety and efficacy against experimental infections of heartworm and intestinal parasites of an ivermectin/pyrantel combination chewable.

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A chewable formulation containing ivermectin and pyrantel (as pamoate salt) was evaluated in dogs for efficacy against endoparasites. When dogs were dosed at 6 mcg ivermectin and 5 mg of pyrantel/kg body weight, efficacy against *D. immitis* L3 larvae and adult *Ancylostoma caninum, Uncinaria stenocephala, Toxocara canis* and *Toxascaris leonina* was 100%, 98.5%, 98.7%, 90.1% and 99.2%, respectively. Efficacy against these parasites was supported by extensive field trials using client's animals. A bioequivalence study using [3H]-ivermectin with and without pyrantel in the chewable formulation demonstrated that the presence of pyrantel does not interfere with the bioavailability of ivermectin. This finding, as well as the converse (i.e. the non-interference of ivermectin with the activity of pyrantel), was confirmed in component efficacy studies.

Studies were conducted in which growing dogs were given the target dose of both compounds or 2X the pyrantel dose with the 1X dose of ivermectin for 5 days, pups were given 1, 3, or 5X the target dose for 3 successive days on 3 occasions in 1 month, or breeding male and female dogs were given 3X the target dose for extended periods prior to breeding, during gestation and through weaning. Extensive clinical observations and clinical chemistry, clinical pathology and gross and histologic morphology evaluations were conducted. No adverse effects could be attributed to the use of the product.

FIELD EFFICACY OF AN IVERMECTIN-PYRANTEL COMBINATION CHEWABLE AGAINST ASCARIDS AND HOOKWORMS IN DOGS. A.D. JERNIGAN*1, R. ALVA1, T. CLEKIS2, T.R. MCARTHUR3. IMSDRL, RAHWAY, NJ 06075; 2CHARLESTON, SC 29405; 3VIDALIA, GA 30474.

A study was conducted at two Southeastern trial sites to evaluate the field efficacy of a chewable formulation containing ivermectin and pyrantel against ascarids and hookworms. In Charleston, South Carolina, 29 dogs were treated with 3 oral doses of the ivermectin/pyrantel chewable at monthly intervals. In Vidalia, Georgia, 28 dogs received the same treatment monthly for 3 months. The chewable provided ≥ 6 mcg/kg b.w. of ivermectin and ≥ 5 mg/kg b.w. of pyrantel as the pamoate salt. All dogs enrolled in the trials were shedding hookworm and/or ascarid eggs based on fecal examinations at the start of the trials. Fecal examinations were performed again after the third monthly dose. At that time, no hookworm or ascarid eggs were detected in feces from 55 dogs. One dog with hookworm and ascarid infections at the start of the trial was cleared of ascarids but was positive for hookworms 39 days after the third treatment, indicating possible reinfection. A dog with ascarid infection was cleared of ascarids but developed a hookworm infection by the end of the trial. Overall, ascarid egg output was eliminated in 100% of previously infected dogs and hookworm egg output was eliminated in 96% of dogs. No adverse reactions associated with drug administration were observed.
EFFICACY OF DEC/OXIBENDAZOLE, IVERMECTIN, IVERMECTIN + PYRANTEL PAMOATE, AND MILBEMYCIN OXIME AGAINST ROUNDWORM AND HOOKWORM INFECTIONS IN DOGS. S.E. MARLEY*1, M.L. MICHALSKI1, R. CORWIN1 AND M. VAN SCHOYCK2. 1DEPT. VET. MICRO., UNIV. MISSOURI, COLUMBIA MO 65211 AND 2SMITHKLINE BEECHAM, EXTON PA 19341.

A comparison of 4 commercially-available anthelmintics was performed to determine relative efficacies. These were diethylcarbamazine-oxibendazole = DEC/OBZ, SmithKline Beecham; ivermectin = IVM, Merck; ivermectin, Merck - pyrantel pamoate, Pfizer = IVM-PY; and milbemycin = MBM, Ciba Geigy. These are primarily for prevention of adult Dirofilaria infections in dogs but have been approved or surmised efficacious for Ancylostoma and perhaps Toxocara. Because of inquiries as regards the broader spectrum activity of these dewormers, a study was conducted to compare their efficacies in dogs given Ancylostoma L3 and Toxocara larvated (L3) eggs. Fifty Beagles, 7-12 wks old, were randomly assigned to 5 treatment groups with A - no medication, B - IVM, C - IVM-PY, D - MBM, and E - DEC/OBZ. Fecal examinations were made each week from days -14 through +90; quantitations (epg) were made from days +21 through +90 using the Wisconsin double centrifugation technique with MgSO4. All dogs were dewormed with these anthelmintics by label recommendation monthly beginning day 0 except for DEC/OBZ given daily. Ancylostoma caninum and Toxocara canis were orally administered weekly from day 0 to day 56. DEC/OBZ was consistently effective in suppression of epg during the course of the study and the other anthelmintics were efficacious immediately following administration but epg reappeared following reinfection and prior to treatment.

EFFICACY OF MILBEMYCIN OXIME AGAINST ANCYLOSTOMA TUBAEOFORME IN EXPERIMENTALLY INFECTED CATS. B. L. BLAGBURN*, C. M. HENDRIX, J. L. VAUGHAN, D. S. LINDSAY, AND D. I. HEPLER. COLLEGE OF VETERINARY MEDICINE, AUBURN UNIVERSITY, AL 36849 AND CIBA-GEIGY CORPORATION, GREENSBORO, NC 27410.

Twenty-four mixed-breed, male and female, random source kittens were each inoculated subcutaneously with either 1,000 or 1,500 laboratory cultivated L3 larvae of A. tubaeforme. Eggs of A. tubaeforme were obtained from experimentally infected donor kittens. Following patency, kittens were ranked from greatest to least based on numbers of hookworm eggs shed per gram of feces. Using this ranking, kittens were then allotted to 4 treatment groups of 6 cats each to equalize levels of infection in each group. Kittens in each group were treated orally with milbemycin oxime at the following dosages: Group I-nontreated; Group II-0.5 mg/kg body weight; Group III-1.0 mg/kg; Group IV-1.5 mg/kg. Kittens in each group were euthanatized 7 days after treatment for recovery of hookworms. Mean numbers ± standard deviations of hookworms recovered from kittens in each group and percentage reduction compared to controls were as follows: Group I- 109 ± 99 worms; Group II-82 ± 53 worms, 24% reduction; Group III-27 ± 21 worms, 75% reduction; Group IV-9 ± 5 worms, 92% reduction. Adverse reactions to treatment were not observed. Results support the activity of milbemycin oxime against A. tubaeforme.
IN VITRO ANTIFUNGAL ACTIVITY OF NAFTIFINE AGAINST *MICROSPORUM CANIS*.
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*Microsporum canis* is a zoophilic transmitted dermatophyte frequently isolated from cats and dogs and occasionally from other animals. This fungal agent can also infect man. We studied its in vitro susceptibility and morphological changes induced by naftifine. Antifungal activity is measured in term of minimum inhibitory concentrations (MICs). MICs are determined against 20 strains of *M. canis* and evaluated by Steers agar dilution method using the Sabouraud medium agar pH 6.8. Values are assessed after 7 days incubation at 28-30°C. Naftifine demonstrates highly in vitro activity with MIC ranged between 0.049 and 0.390 µg.ml⁻¹.

The action of this antifungal agent on hyphae filaments and conidia is studied by low voltage scanning electron microscopy (LVSEM) and transmission electron microscopy (TEM). The effects of naftifine consist of swollen hyphae with wrinkled knob-like portions. Phenomenons of microfilamentation can be observed on the macroconidial surface. The TEM shows invaginations, detachment, break of the plasmalemma and cytoplasmic accumulation of refringent vesicles.

HYPERIMMUNE BOVINE COLOSTRUM, A UNIQUE TREATMENT FOR AVIAN COCCIDIOSIS DUE TO *EIMERIA ACERUVULINA*. R. FAYER AND M.C. JENKINS. USDA,ARS. BELTSVILLE, MD 20705.

Hyperimmune bovine colostrum (HBC) was produced by immunizing nonlactating Jersey cows with *Eimeria acervulina* (Ea) antigens (Ags) at 10, 8, 6, and 4 wk before expected parturition. Cow 1 was immunized with sporozoites (S), Cow 2 with merozoites (M) and Cow 3 with recombinant merozoite Ag (rM). The 1st immunization was intramuscular, the following were intramammary infusions through the teat canals. Cow 4 provided nonimmunized control colostrum (NC). Colostral whey from each cow was tested by ELISA for antibody (Ab) against S, M, and rM Ags. AntiEa titers were elevated in Cows 1-3 above Cow 4. Ab from Cows 2 & 3 recognized both M and rM Ags. Separate groups of 2-wk-old chickens received 2 oral doses daily of colostral whey from Cows 1-4 or PBS alone from 1 day before to 6 days after oral inoculation with Ea oocysts. In 2 exps. oocyst production by all HBC treated groups except one was less than NC or PBS treated controls. In 1 exp. lesion scores of all HBC treated groups were less than NC or PBS treated controls. Significantly fewer developmental stages were found in duodenal tissue sections from groups treated with antiS or antiM HBC than in controls. These findings suggest that HBC specific for certain Ea Ags can inhibit parasite development and reduce lesions.
PATENT INFECTIONS OF ASCARIS SUUM IN PIGS: EFFECTS OF PREVIOUS EXPOSURE TO MULTIPLE, HIGH LEVELS OF INFECTION AND ANTHELMINTIC TREATMENT REGIMES.
M. STANKIEVICZ, W. JONAS, AND D.L. FROE II*.

Fifty-four crossbred, 4-week-old pigs divided into 9 equal groups were used to test whether multiple infections inoculations with high numbers of A. suum would result in patent infections. It was also tested whether multiple exposures if controlled therapeutically with either pyrantel tartrate or fenbendazole will affect susceptibility of pigs to a single inoculation with a large number of embryonated eggs (10,000).

Patent infections were not readily developed in pigs given a single dose of 10,000 eggs. However, all pigs harbored adult worms when each was exposed to multiple pre-challenge inoculations of 500, 1000, 2000, 5000, 10,000, and 20,000 and challenged orally, two weeks later, with 10,000 ova.

Pigs subjected to multiple egg dosing but given fenbendazole continuously before, during, and for 10 days after pre-challenge infections developed significantly more adult intestinal worms after challenge (i.e., 30 vs. 10 and 0.5) than pyrantel purge or continuous administration (same as FBZ), respectively. Intestinal worms in Fendazole treated pigs were significantly shorter than those that developed in other pigs. Adult worms from all groups produced eggs that after embryonation were infective to mice.

When challenge infections were not given, neither pyrantel nor fenbendazole treated pigs developed patent infections.

EFFECTS OF DEWORMING A BEEF COW/CALF HERD WITH ALBENDAZOLE IN THE NORTH CENTRAL UNITED STATES. B.E. STROMBERG*, D.L. HAGGARD AND D. BROWN. UNIVERSITY OF MINNESOTA, ST. PAUL AND GRAND RAPIDS, MN 55108 and 55744.

A cow/calf herd that was know to be parasitized with Ostertagia ostertagi, Cooperia oncophora and Nematodirus helvetianus was utilized in a study to evaluate the effects of strategic deworming with albendazole. Forty-eight head of crossbred cows and their calves were allotted into two equal groups, based on age and sire of the dam. Pastures were of approximately equal size and forage composition. These pastures had been grazed by parasitized cattle for the previous three seasons. Cows in the treated group received albendazole orally at a dose rate of 10 mg/kg of body weight two days before turnout onto pasture in spring (May). At midsummer (July) the treated cows and their calves were given albendazole at the same dose rate. Fecal egg counts were determined monthly throughout the season. Tracer calves were grazed with each herd for one month periods throughout the season.

Treatment resulted in egg count reductions for both treated cows and calves. Nematodirus egg counts rose late in the grazing season in the control group, September and October. The data from the tracer calves showed an increase in total worms recovered over the grazing season and that there was a significant population of Nematodirus helvetianus on both pastures. There was a 30.83 lb weight advantage at weaning and a 30.79 lb 205-day adjusted weaning weight advantage for the treated calves.
EFFICACY EVALUATION STUDIES ON ABAMECTIN AND MORANTEL IN CATTLE. T.A. YAZWINSKI* AND H. FEATHERSTON. UNIVERSITY OF ARKANSAS, FAYETTEVILLE, AR 72701

Control studies were conducted to evaluate the efficacy of abamectin against induced fourth-stage larval and adult nematode parasites of cattle. For all nematodes studied (B phlebotomum, C oncophora, C spatulata, C surnabada, C punctata, D viviparus, H placei, N helvetianus, O radiatum, O ostertagi and T axe) efficacies were >99% for both targeted stages. All treatments were given once, subcutaneously, and at the dose level of 200 mcg/kg body weight. No adverse reactions to treatment were encountered.

In each of two successive years (1988 and 1989), the anthelmintic effectiveness of morantel tartrate as supplemented in a mineral mix was evaluated in the control of naturally acquired nematodiasis. For each study, a 63 day treatment period of ad libitum consumption was observed; with a targeted morantel consumption of 152 mg/hd/day. Pre-treatment and principal animals (treatment vs control) were necropsied each year for nematode recoveries. For each study, morantel-supplemented mineral mix was consumed at approximately 66% of target with resultant overall efficacies of 60.4 and 21.5% for the 1988 and 1989 studies, respectively. Ostertagia ostertagi burdens proved most refractory to treatment.


Four trials utilizing from 12 to 20 animals in each trial were conducted to determine the efficacy of abamectin in a 1% w/v solution injected subcutaneously at 200 mcg/kg against 1st, 2nd and 3rd stage larvae of Hypoderma spp. and three species of sucking lice, Haematopinus eurysternus, Linognathus vituli, and Solenopotes capillatus.

In the two trials utilizing cattle infected with Hypoderma spp. larvae, no live larvae were recovered from any animal treated with abamectin, while live larvae were recovered from all untreated control animals.

No live sucking lice were found on any abamectin-treated calves seven or more days after treatment until trial termination 56 days after treatment. Differences in numbers of lice observed on treated vs. control animals were significant for all species in both trials from day 7 until at least day 42.

No adverse or unexpected reactions were observed.
COMPARISON OF TREATMENT STRATEGIES WITH IVERMECTIN (IVM) FOR CONTROL OF GASTROINTESTINAL NEMATODES OF CATTLE IN LOUISIANA.

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During a year of high infection risk, a nematode control strategy based on a concentration of 3 IVM treatments from weaning time, controlled parasitism, but did not yield final gains significantly greater than gains of a group treated with IVM at strategic long intervals. Three groups of 11 weaner-yearling beef heifers were grazed on separate pastures from NOV 1990 to OCT 1991 and treated as follows: group 1-treated with IVM on NOV 13, DEC 27, FEB 4 and JUN 26; group 2-treated with IVM on NOV 13, MAR 5 and JUN 26; group 3-treated with IVM on NOV 20 only. All IVM treatments were SC at 200μL/kg. Winter conditions were mild and rainfall was most often above average from DEC through JUN. Group 1 fecal egg counts and pasture larval counts were consistently lowest; those of group 2 were increased during winter and spring, but remained lower than those of group 3. Bodyweights of group 1 cattle were often significantly greater than those of group 2, but in the final weigh interval, the mean weight of group 2 (310.9 kg) closed to within 5.5 kg of group 1 (316.4 kg). Evidence of type II ostertagiasis was observed in abomasal pathology and large worm counts (including inhibited larvae) of group 3 cattle at necropsy in OCT.

EFFECTS OF IMMATURE LIVER FLUKES ON GRAZING STOCKER CATTLE AND OF ADULT LIVER FLUKES ON FEEDLOT CATTLE, AND STRATEGIC DEWORMING WITH IVOMEC-F®. S.E. MARLEY1*, D.P. HUTCHESON2 AND R.M. CORWIN1, 1DEPT. VET. MICRO., UNIV. MISSOURI, COLUMBIA, MO 65211 AND 2AGRIC. RES. AND EXT. CENTER, TEXAS A&M UNIV., AMARILLO, TX 79106

The efficacies of ivermectin and of clorsulon have been well documented against a broad range of internal and external parasites, and of liver flukes, respectively. European studies indicate the immature fluke has little to no effect on the performance of grazing stocker calves and that the bile duct stage of Fasciola hepatica (ca. 8 weeks p.i.) is the stage which causes the most economic and physiological damage in cattle. Moreover, limited data have been published on the effect of liver flukes on performance of cattle once they enter the feeding phase of their production cycle. The objectives were to determine the effects of immature liver flukes on performance, serum albumin and GGT (measured biweekly) of grazing stocker steers, then treating fluke-infected feedlot steers with IVOMEC-F® (ivermectin-clorsulon) and determine their subsequent feedlot performance as measured by rate of gain, feed efficiency, serum albumin, PCV and GGT. Sixty yearling crossbred steers were experimentally infected with 500 metacercaria on Day 0 and another 60 were not infected (controls). All animals were treated with IVOMEC® Pour-On and allowed to graze on cool season grass pastures for 68 days in Missouri. On day 74, the 60 fluke infected steers were transported to a Texas feedlot where 30 were treated with IVOMEC-F® and 30 with IVOMEC® injectable. Weights, PCV, serum albumin, and GGT were measured every 28 days. Grazing phase results suggest that immature flukes do not cause a decrease in performance. Results of the feedlot phase will be discussed.

A break was identified in the large subunit ribosomal RNA of *Trichinella spiralis* that results in its dissociation into two smaller fragments of equal length. The approximate location of the break within the encoding gene was mapped from subcloned rDNA fragments by S1 protection experiments. The boundaries of the break were determined by cDNA primer extension and S1 nuclease protection assays. The excised fragment (gap sequence) was localized to expansion segment 5 within domain IV from which 86 bases are removed during the excision process. The gap region is flanked by the consensus sequence CGAAAG; however, comparison of expansion segment 5 sequences from *T.spiralis*, *T. nativa*, *T.nelsoni* and *T. pseudospiralis*, all of which undergo "gap processing", demonstrates significant size and sequence heterogeneity and provides little evidence for additional consensus sequences which could be implicated in gap processing.


Classification within the genus *Haemonchus* remains a controversial issue primarily with respect to the sheep and bovine nematodes *Haemonchus contortus* and *Haemonchus placei*, respectively. Morphological and biological similarities among these nematodes as well as their potential to infect both hosts has prompted the development of a method for rapid and reliable differentiation and the initiation of studies at the molecular level to further clarify their relationship within this genus. To this end, we have cloned and mapped the rRNA gene repeats from *H. contortus*, *H. placei* and *H. similis* and from these maps developed polymerase chain reaction (PCR) primers that can be used in the differentiation of *H. contortus* and *H. placei*. Results indicate two distinct rRNA gene repeats within each species. Further, one set of PCR primers which span the non-transcribed repeat on both species can unequivocally and rapidly differentiate these parasites using single worms.

We have cloned and characterized a cDNA encoding collagen from the parasitic nematode Haemonchus contortus. The cDNA is 1110 base pairs in length and encodes an open reading frame of 180 amino acids. The domain structure of the protein predicted by the nucleotide sequence is similar to that found in other nematode collagen gene families. Of note are 2 triple helix forming regions, characterized by (Gly-X-Y)$_n$ repeats, of 24 and 128 amino acids in length. These domains are flanked by conserved regions containing cysteine residues. Based on comparison of these cysteine-rich regions, this collagen, which we term HcCol-2, does not appear to be a member of the 3A3 collagen gene family previously described in H. contortus. Instead, it is more closely related to the product of the Col-19 gene family found in Caenorhabditis elegans. This finding suggests that multiple collagen families exist in H. contortus, as is the case for C. elegans. Northern hybridization experiments showed that the expression of this gene is developmentally regulated.

A CLONED FILARIAL ANTIGEN, Di5, RELEASED FROM DIROFILARIA IMMITIS. L. A. McREYNOLDS*, Y. HONG AND C. B. POOLE, NEW ENGLAND BIOLABS, BEVERLY, MA. 01915.

Cloned filarial antigens are valuable reagents for use in understanding the basis of immunity and pathology in parasitic infections. Antisera from dogs immunized with irradiated L3s of D. immitis was used to screened a lambda gt11 cDNA library. One recombinant antigen, called Di5, was determined by DNA sequence analysis to be a 399 base pair repeat. A Western blot, using specific antisera generated to the cloned Di5 protein, showed a striking ladder-like pattern in extracts of D. immitis adults. The native protein has over 20 similar repeats [16kD] that are organized in a tandem array. Pulse chase studies indicate that it is synthesized as a very high molecular weight precursor, over 200kD, and then cleaved to generate the ladder-like array.

The Di5 monomer is the major excretory/secretory protein of adult male and female D. immitis. Western blot analysis of culture media from D. immitis adults revealed a protein the same size as Di5. The Di5 protein is antigenic in immune and infected dogs. Anti-Di5 IgG antibody titers increase in D. immitis infected dogs as immature adult parasites reach the heart. DNA hybridization studies and sequence comparisons demonstrate that this protein is present in other parasitic nematodes including: Brugia malayi, Brugia pahangi, Loa loa and Ascaris suum. Studies are underway to determine the function of this unusual protein family in parasite biology and host pathology.

Two molt associated proteins have been described in the excretory-secretory products (ES) collected from *D. immitis* during the molt from the third stage to the fourth stage *in vitro*. During the purification of these two proteins a third protein has been identified. All three have molecular weights in the 20 to 23 kilodalton range.

ES was collected from larvae cultured under serum free conditions between 48 and 144 hours in culture after being primed with 20% fetal bovine serum for the first 48 hours. The three proteins of interest were purified by HPLC using cation exchange chromatography followed by reverse phase chromatography using a butyl column. All three proteins were subjected to trypsin digestion and their peptides separated by reverse phase chromatography on an octadecyl column. The largest of the three proteins has also been found in adults using the same purification scheme and tryptic mapping. Amino acid sequences were determined on at least three peptides from each protein. These sequences will be used to synthesize degenerate oligomeric DNA probes to be used to clone the molecules from larval and adult cDNA libraries. (Supported by Paravavax, Inc.).

A cDNA ENCODING AN ANTIGEN PRESENT ON EIMERIA ACERVULINA SPOROZOITES AND MEROZOITES. P.G. SEFERIAN* AND M.C. JENKINS. PDL, LPSI, USDA, AGRICULTURAL RESEARCH SERVICE, BARC-EAST, BELTSVILLE, MD 20705.

A cDNA clone was identified that encodes proteins present on both the sporozoite and merozoite stages of the avian parasite *Eimeria acervulina*. cDNA clone EAMZ92/120 was derived from merozoites and identified using antisera prepared against denatured merozoite membrane proteins. Immune serum generated against recombinant EAMZ92/120 protein recognized a 92 kDa native protein present on both sporozoite and merozoite stages of the parasite as well as a second 120 kDa native protein that is present on merozoites but not sporozoites. EAMZ92/120 encoded antigens are present internally and on the surface of live or air dried sporozoites and merozoites, as indicated by immunofluorescence studies using antisera raised against recombinant protein. Anti-recombinant EAMZ92/120 serum also identified antigens present on all asexual stages of the parasite within tissues from *E. acervulina* infected chickens. Sequence analysis revealed that EAMZ92/120 cDNA is 952 bp long and encodes a single open reading frame. EAMZ92/120 appears to represent a single copy gene within the parasite genome as determined by DNA hybridization. RNA hybridization revealed that EAMZ92/120 recognizes two distinct RNA species in merozoites and a single prominent RNA species in sporozoites. In addition, purified recombinant EAMZ92/120 protein specifically induced significant proliferative responses in *E. acervulina* immune chicken T-cell enriched lymphocyte preparations. This suggests that immunity to EAMZ92/120 protein may be involved in the protective response of immune chickens to coccidiosis.
LECTIN BINDING TO EOSINOPHIL GRANULES AS A METHOD OF DETECTING EOSINOPHIL PRODUCTS IN PARASITIZED TISSUES. C.D. MACKENZIE, C. AYALA AND D. CRAFT. DEPARTMENT OF PATHOLOGY, MICHIGAN STATE UNIVERSITY, EAST LANSING, MI 48824.

Lectin binding to eosinophil granules has been described for isolated blood derived cells and shown to be comparatively selective for this granule type. We have shown that the lectin can be used in tissues to identify both eosinophil granules in intact cells and granular material subsequent to degranulation and deposition of this material in tissues. We propose that the lectin can be used to simplify identification of extracellular location of eosinophil granular material in histological sections.

PATHOGENESIS AND IMMUNE CHANGES DURING PRIMARY AND SECONDARY EXPERIMENTAL INFECTIONS OF DOGS WITH BRUGIA PAHANGI. D. SCHREUER AND B. HAMMERBERG.* NORTH CAROLINA STATE UNIVERSITY. RALEIGH, NC 27606.

In Brugia pahangi infected beagle dogs changes in humoral and cellular immune responses by PBMC and lymph nodes of infected and uninfected limbs were monitored during the first 42 weeks of infection. When 3 of 5 dogs from the same litter received 15 third stage larvae(L3) in the paw of both rear limbs, all 3 infected dogs demonstrated strong cellular and humoral immune responses in lymph nodes that drained the site of infection as determined by B. pahangi antigen (BpA) specific in vitro blastogenesis and in vitro BpA specific IgG production. Lymph node cells from both uninfected dogs failed to produce BpA specific responses detectable in either of these 2 assays. Enlargement of the lymph node draining the site of infection was detected as early as 4 weeks post infection. Two dogs showed limb edema and palpable fibrosis of the lymphatic duct afferent to the infected node starting at 7 weeks post infection. At this latter time infections in 2 of the 3 dogs demonstrated onset of patency as determined by the presence of microfilariae in biopsy material from popliteal lymph nodes draining the site of infection. In the third dog, microfilaremia was not detected before 30 weeks post infection. Although the 3 infected dogs were able to mount parasite specific cellular and humoral immune responses early during infections these responses abruptly decreased in intensity at variable times later during infection. To determine whether reinfec tion might boost these responses, a second injection of 10 L3 was administered in the right rear limb only. Reinfec tion failed to enhance proliferative responsiveness by unresponsive lymph node cells from one dog, and instead resulted in the inhibition of the previously established proliferative responsiveness and in a marked increase in parasite specific antibody production by infected lymph node cells of the 2 other infected dogs.
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PATHOPHYSIOLOGICAL CHANGES IN GROUSE AND CHICKENS INFECTED WITH TRICHOSTRONGYLUS TENUIS. G.R. WILSON, C.D. MACKENZIE*, & M. WORMS.
DEPARTMENT OF THE ENVIRONMENT, AUSTRALIAN FEDERAL GOVERNMENT, CANBERRA, ACT; DEPARTMENT OF PATHOLOGY, MICHIGAN STATE UNIVERSITY, EAST LANSING, MI 48824; NATIONAL INSTITUTE FOR MEDICAL RESEARCH, MILL HILL, LONDON NW7 1AA, UK.

The life cycle of T. tenuis in chickens, as well as the pathophysiological and immunological changes were investigated and compared to those seen in natural and experimentally infected grouse (Lagopus lagopus scoticus). The pathogenic effects of this parasite varied between individual birds, some effects only to a minor degree but others suffering severe changes as monitored by vitality, aggressiveness, blood parameters, immune responses to the parasite and tissue changes. The effects of these findings on the overall survival of grouse in the wild will be discussed.

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EXCYSTATION AND DEVELOPMENT IN VITRO AND IN VIVO OF EIMERIA TENELLA AFTER IRRADIATION OF OOCYSTS. L.R. MCDougald*, A.L. Fuller, J. Gilbert, and T. Scott. DEPT OF POULTRY SCIENCE, UNIVERSITY OF GEORGIA, ATHENS GA 30602.

Sporulated oocysts of E. tenella were exposed to 50, 100, 150 or 200 Grays of ionizing radiation from a cobalt-60 source. Oocysts walls were broken by shaking with glass beads for in vitro studies or were given orally to chickens.

Excystation after exposure of sporocysts to trypsin/taurocholate was more rapid in irradiated oocysts than in control oocysts, and was especially noticeable after 30 minutes. By 60 minutes there was no difference in excystation rate.

Sporozoites from irradiated batches appeared normal and parasitized cells when inoculated into cell cultures. There was some reduction in penetration rate at 200 Grays. Only a few sporozoites from irradiated oocysts developed into first generation schizont in vitro, even though large numbers were found intracellulary. When oocysts were inoculated into chickens, there was a reduction in reproductive potential that was generally proportional to the radiation dosage.
Paraherquamide, an oxindole alkaloid metabolite of Penicillium paraherquej and P. citrinum, is a new anthelmintic entity with a novel mode of action. It was tested against adult stages of 6 gastrointestinal nematodes of sheep at single, oral dosages of 0.25, 0.5, 1.0 or 2.0 mg/kg. At dosages ≥0.5 mg/kg there was ≥95% removal of Haemonchus contortus, Ostertagia circumcincta, Trichostrongylus axei, T. colubriformis and Cooperia curticei. The isolate of H. contortus used was ivermectin-resistant and the isolate of T. colubriformis used was benzimidazole- and ivermectin-resistant. No adverse reaction was observed in the sheep. Paraherquamide was also tested against the adult stages of 9 gastrointestinal and lung nematodes of calves at single, oral dosages of 0.5, 1.0, 2.0 or 4.0 mg/kg. At dosages ≥1.0 mg/kg there was ≥95% removal of H. placei, O. ostertagi, T. axei, T. colubriformis, C. oncophora, Nematodirus helvetianus, Oesophagostomum radiatum and Dictyocaulus viviparus. No adverse reaction was observed in the calves. Paraherquamide was subsequently tested against the adult stages of 5 intestinal nematodes of dogs at single, oral dosages of 0.5, 1.0 or 2.0 mg/kg. No dosage produced useful broad-spectrum activity against Ancylostoma caninum, Uncinaria stenocephala, Toxascaris leonina, Trichuris vulpis or Strongyloides stercoralis. All dosages, however, did produce significant toxicosis. The mode of action of paraherquamide is not fully understood in any host species but it is clear that dogs are more sensitive to the compound than are ruminants and the converse is true of their parasites.

DAILY EVALUATION OF THE SUPPRESSION OF NEMATODE EGG PRODUCTION IN SHEEP BY TREATMENT WITH THIABENDAZOLE, LEVAMISOLE OR IVERMECTIN. R. A. Valdez*, J. A. DiPietro, A. J. Paul, and K. S. Todd, Jr., Department of Veterinary Pathobiology, College of Veterinary Medicine, University of Illinois, Urbana, IL 61801.

The objective of this study was to determine on a daily basis what effect treatment with thiabendazole (TBZ), levamisole (LVM), and ivermectin (IVM) had on passage of nematode eggs in sheep feces.

Thirty-three crossbred sheep were ranked by descending nematode egg count (NEPG), randomly allocated in replicates of 3 to treatment groups, and treated orally on day 0 with 44 mg of TBZ /kg, 8 mg of LVM /kg, and 0.2 mg of IVM /kg. Quantitative fecal examinations were carried out prior to treatment and on days 1, 2, 3, 4, and 14 on sheep treated with anthelmintics and 3 untreated control sheep. Samples from control sheep detected the presence of nematode eggs (mean = 197 NEPG) on all days of the study. The mean NEPG of sheep treated with anthelmintics and % of sheep detected passing nematode eggs were as follows:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pre TX</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBZ</td>
<td>350 (100)</td>
<td>215 (60)</td>
<td>95 (50)</td>
<td>70 (20)</td>
<td>105 (50)</td>
<td>75 (60)</td>
</tr>
<tr>
<td>LVM</td>
<td>680 (100)</td>
<td>45 (60)</td>
<td>10 (20)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>5 (10)</td>
</tr>
<tr>
<td>IVM</td>
<td>300 (100)</td>
<td>10 (20)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>15 (10)</td>
</tr>
</tbody>
</table>

Data expressed as mean NEPG (% of sheep detected passing nematode eggs)

Results of this study indicate that sheep parasite control strategies utilizing turn-out to safe pasture would be most beneficial if turn-out occurs 2 and 3 days after treatment with IVM and LVM respectively. Treatment with TBZ was of little benefit.
IN VITRO AND IN VIVO EVALUATION OF SELECTED β-KETOAMIDES AND
DIOXAPYRROLOMYCIN FOR CROSS-RESISTANCE WITH KNOWN
ANTHELMINTICS. S.S. JOHNSON1*, G.A. CONDER1, D.P. THOMPSON1,
E.M. THOMAS1, D.L. COX1, D.S. NOWAKOWSKI1, T.E. BLAKE1, T.G. GEARY1,
J.T. ROTHWELL2, N.C. SANGSTER2, T. HARRIS* AND G.C. COLES3. 1UPJOHN
LABORATORIES, KALAMAZOO, MI 49001, 2UNIVERSITY OF SYDNEY, NSW
2006, AUSTRALIA, AND 3CENTRAL VETERINARY LABORATORY, NEW HAW,
WEYBRIDGE, SURREY KT15 3NB, ENGLAND.

Selected β-ketoamides (U-87407 and U-88509) and dioxapyrrolomycin (U-88599),
which have some structural similarity with and exhibit comparable biological
activity to closantel, were examined to determine if they are cross-resistant with
closantel or with any of the 3 major anthelmintic classes (benzimidazoles,
ivermectin, and levamisole). Cross-resistance was evaluated in in vitro (motility and
migration) and in vivo (jirds and lambs) assays using drug-resistant and
-susceptible strains of Haemonchus contortus. None of the 3 U-compounds appeared
to be cross-resistant with benzimidazoles, ivermectin, or levamisole, but all 3
exhibited cross-resistance with closantel. Based on these studies, neither the
β-ketoamides or dioxapyrrolomycin are suitable for use as narrow-spectrum,
H. contortus-only anthelmintics, since closantel resistance is already a problem in
the field.

ENHANCED GROWTH OF ALVEOLAR HYDATID CYSTS IN PRAZIQUANTEL-
TREATED JIRDS (MERIONES UNGUICULATUS). R. MING* AND F. L.
ANDERSEN, BRIGHAM YOUNG UNIVERSITY, PROVO, UT 84602; A. A.
MARCHIONDO, FERMENTA ANIMAL HEALTH, KANSAS CITY, MO 64153; G.
A. CONDER, UPJOHN LABORATORIES, KALAMAZOO, MI 49001; AND J. H.
SLUSSER, EAST VIRGINIA MEDICAL SCHOOL, NORFOLK, VA 23501.

Jirds infected intraperitoneally with protoscolices of Echinococcus multilocularis were
treated with praziquantel (PZQ) or vehicle (DMSO) per os at a daily dose of 300 mg/kg and
with different 5-day regimens starting at 29 days post-inoculation (DPI). At 39 or 49 DPI, growth of larval cystic
mass (LCM) measured by cyst weight and ratio of cyst weight to
body weight was significantly higher in PZQ-treated jirds than
in vehicle controls. At 69 DPI the average LCM of PZQ-treated
jirds was still more than in control jirds, but was no longer
significantly different. Despite the LCM being consistently
larger in the PZQ-treated animals, TEM studies showed that PZQ
treatment consistently produced vacuolization of germinal
membranes with swelling and rounding of mitochondria. It is
postulated that PZQ treatment impairs cell mediated immune
factors which might ordinarily inhibit growth of LCM in the
early stages following infection.

There are unique interactions among fish, parasites and the aquatic environment. As fish are mostly water, separated only by a simple plasma membrane from the aquatic milieu, alterations in water quality can have significant adverse effects on fish health. Little is known on life cycles, systematics, pathogenesis of infection, diagnosis, epidemiology, treatment, and control of parasites of cultured finfish or shellfish. There is need for in vitro and in vivo experimental models of parasitic infection and disease with piscine hosts. Relatively little is known of finfish immunology, with only rudimentary knowledge of shellfish immune responses available. Broad knowledge of the aquatic environment is essential to effectively relate clinical findings to disease entities. Disease must be managed throughout the life cycle of fish, including freshwater and saltwater phases where appropriate. Disease prevention is biologically and economically the most correct approach to fish health. Subclinical parasitic diseases are likely important to fish farms. When epidemics occur, salvage mechanisms are required to maintain economic viability of aquacultural industries. An integrated approach to management of parasitic disease includes environmental management, chemoprophylaxis, chemotherapy, immunization, selective breeding for resistance, and quarantine. Parasite control decisions must be based on cost-benefit analyses. Various stressors can induce parasitic infection to manifest as overt disease; consequently treatment must reduce triggering stressors. Transfer of parasites from wild fish stocks to farmed stocks occurs, as does the reverse. Adequate nutrition is essential to reduce the impact of parasitic infections in aquacultural operations. Overall, veterinary parasitologists can contribute significantly to ensure healthy fish and further development of aquaculture.

PARASITE EFFECTS ON ANIMAL PERFORMANCE- AN ANIMAL SCIENCE COURSE. T.B. STEWART*, J.E. MILLER AND T.K. KLEI. LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA. 70803.

A course designed for advanced and graduate students in Animal Science was conducted in the fall of 1991. The objectives were to: 1) acquaint the students with the variety of parasites in farm animals, 2) gain an understanding of parasite effects on animal performance, 3) learn procedures to evaluate effects of parasites and 4) appreciate the role of management and nutrition on the prevention and control of parasites. Weekly lectures were followed by a laboratory. The students participated in a trial with 20 pigs to determine the effect of *Ascaris suum* infection on performance and carcass quality. Field trips were made to production units, fecals collected and analyzed for worm eggs and parasites recovered at slaughter of pigs. Each student wrote a paper on the importance of parasites in a specific host animal as well as one on the class experiment. Evaluation of the course by students indicated that they would highly recommend it to others, that the experiment and the paper on their chosen host animal were valuable parts of the course.

Six pony yearlings treated at 8 week intervals with ivermectin and six pony yearlings that had not been treated for parasites were used in this experiment. Prior to Apparent Digestibility Coefficient (ADC) determination mean strongyle EPG's were 0 to 2.4 for Ivermectin treated yearlings and 246 to 601 for non-treated yearlyings. The yearlings were fed a chromium oxide (CrO\textsubscript{7}) marker to facilitate calculation of ADC's. Multiple samples were collected from each pony and subjected to nutritive analysis for their protein (CP), fat (EE), fiber (CF), and ash content. Nitrogen free extract (NFE), which is the largest component of the carbohydrate content of the feed or feces is customarily determined by difference. The mean CP ADC for the untreated yearlings was 74.86, and for the treated yearlings was 72.99. The mean ADC's for fat (EE) was 60.78 and 61.16 respectively. The mean ADC's for ash were 42.69 and 43.76. The calculated ADC's for NFE were 75.20 for the treated yearlings and 68.66 for the untreated yearlings (.01 < p > = .025). This could indicate heavily parasitized yearlings are less able to digest carbohydrates. Rate of passage comparisons between the two groups were inconclusive. (Supported in part by MSD AgVet). (Hackett and Keys are currently at Cal Poly, Pomona).

NEMATODE SUSCEPTIBILITY AND GENETIC VARIATION IN THE MHC CLASS II REGION BETWEEN DORPER AND RED MAASAI SHEEP FROM KENYA. J.E. MILLER*, N.E. MUGGLI-COCKETT, AND L.E. REYNOLDS. LOUISIANA STATE UNIVERSITY, BATON ROUGE, LA, 70803, UTAH STATE UNIVERSITY, LOGAN, UT 84322, AND THE INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA, MOMBASA, KENYA.

Dorper (D) sheep appear to be more susceptible to nematode (predominantly Haemonchus) infection than Red Maasai (RM) sheep. Overall mean EPG and PCV for D and RM rams were 1071 and 240, and 25.3 and 27.9. Overall mean EPG and PCV for D and DxRM lambs were 429 and 334, and 28.4 and 29.0. Polymorphisms in the major histocompatibility complex (MHC) were investigated and identified using bovine MHC class II beta-chain genes as hybridization probes in restriction fragment length polymorphism (RFLP) analyses. Genomic DNA was digested with EcoRI and hybridized to BoLA DRB3-B2 (46 D and 18 RM) or digested with TaqI and hybridized to BoLA DQB1-TM (54 D and 18 RM). The DRB3-B2/EcoRI combination resulted in eight bands; three of these bands (7.1, 4.8, and 3.4 kb) were nonpolymorphic, two (10.7 and 10.4 kb) were one set, and three (4.4, 3.7, and 2.7 kb) were another set of codominantly inherited alleles. There were no significant differences between RM and D in frequency of these codominantly inherited alleles; therefore, frequencies were pooled across D and RM and were 90.1, 9.8, 5.4, 79.2, and 15.4%. The DQB1-TM/TaqI combination resulted in five codominantly inherited alleles (10.9, 9.2, 6.1, 5.2, and 4.3 kb). There were significant differences in the frequencies of these alleles between D (2.8, 39.8, 13.9, 27.8, and 15.7%) and RM (11.1, 33.3, 36.1, 16.7, and 2.8%) sheep. Using the results of the RFLP analyses, associations between the MHC polymorphisms and nematode susceptibility are under investigation.

Prior to the 1960’s, Echinococcus multilocularis spread from the far northern regions of Canada and Alaska and became established in an endemic focus in central North America, centered in southern Manitoba and North Dakota. From this area, the parasite has progressively extended its range, so that as of 1991 it was known to be endemic in all or part of 10 states (ND, SD, MT, WY, NB, MN, IA, WI, IL, IN) and 3 Canadian provinces (ALB, SAS, MAN). In December 1989, E. multilocularis was identified in 3 red foxes confiscated by authorities in South Carolina; these animals had been illegally translocated from eastern Indiana and were to be released in hunting enclosures in the Southeast. This common practice has the distinct potential for spreading E. multilocularis into other areas. In the north central region, E. multilocularis exists primarily in a sylvatic cycle involving wild canids and rodents. The parasite has been found occasionally in farm cats but not in dogs, although few cats or dogs have been examined. Recent studies using a sylvatic isolate from Indiana indicated that dogs were highly susceptible to infection and therefore could pose a zoonotic threat. Human cases of alveolar hydatid disease have been identified in a man from southern Manitoba and a woman from southwestern Minnesota. As a potential veterinary and human health problem in the contiguous United States, E. multilocularis should be the subject of continued investigation and surveillance.

PREVALENCE, DISTRIBUTION AND INTENSITY OF ECHINOCOCCUS MULTILOCULARIS INFECTION IN WILD CANIDS IN INDIANA AND BORDERING STATES. SCOTT T. STORANDT* AND KEVIN R. KAZACOS. PURDUE UNIVERSITY. WEST LAFAYETTE, IN 47907

The alveolar hydatid tapeworm, Echinococcus multilocularis, was first identified in Indiana in January 1990, in a coyote from Tippecanoe County. Since then, we have been studying the distribution and intensity of this infection in wild canids in this region. During the 1990-91 hunting/trapping season, 768 red foxes, gray foxes and coyotes were collected from Indiana and bordering states. Small intestinal contents were examined for E. multilocularis in a special biohazard containment facility. Of 112 Indiana canids examined by 1/25/92, 15 (13.4%) were found to be infected with E. multilocularis. All infected animals were from the northern half of the state, where 15 of 73 animals (20.5%) were positive. These consisted of 8 of 31 (25.8%) red foxes, 7 of 32 (21.9%) coyotes and 0 of 10 gray foxes. The parasite was also found in 4 of 14 (28.6%) coyotes from east-central Illinois and 2 of 9 (22.2%) red foxes from northwestern Ohio. The latter is a new state record for E. multilocularis. Infected animals had a mean intensity of 463 worms (range 1 - 2,313). If this distribution pattern holds true for additional animals to be examined, it would support the hypothesis that E. multilocularis has spread into this region from the north-central endemic focus (Dakotas, Minnesota) and that it may continue to spread to the south and east. Future studies will continue to examine the epidemiology of E. multilocularis in this region, including the role of feral dogs and cats as hosts of this parasite.
DIFFICULTIES WITH THE IDENTIFICATION OF ECHINOCOCCUS MULTILOCULARIS INFECTIONS IN DOGS AND CATS M.B. HILDRETH, D. BLUNT and S. SAILEELA. DEPARTMENT OF BIOLOGY/MICROBIOLOGY, SOUTH DAKOTA STATE UNIVERSITY.

Echinococcus multilocularis is endemic among wild canids throughout much of the central United States; however, virtually nothing is known of the U.S. distribution of E. multilocularis in dogs and cats. Unfortunately, ante-mortem diagnosis of E. multilocularis in pets is extremely difficult. Since eggs are infectious to humans, diagnostic techniques involving fecal material must be performed with extreme care utilizing proper facilities. We've recently shown that eggs can be killed by storing the material at -70°C for 4 days. Echinococcus gravid proglottids are too small to be recognized in fecal samples. Chemical purgatives such as arecoline can be used to recover whole worms, but its use can produce dangerous side effects, and the holding facilities often become contaminated with fecal material containing infectious eggs. Echinococcus eggs are recoverable by fecal flotation, but unfortunately, these eggs are indistinguishable from eggs of other nonzoonotic taeniid tapeworms commonly found in dogs and cats. The use of molecular and/or immunological techniques to differentiate Echinococcus eggs from those in the genus Taenia are currently being explored in several labs. A polymerase chain reaction (PCR) procedure developed by Gottstein and Mowatt (Mole Biochem Parasitol 1991:44: 183-193) shows good potential for identifying E. multilocularis DNA. Unfortunately, there exist no convenient method for isolating DNA from E. multilocularis eggs. Thus far, we have not been able to breach the onchospheral membrane with cell lysis agents (i.e. Proteinase K and Triton-X 100) traditionally use for the isolation of DNA from other types of tissue. Differences in the excretory/secretory antigens from E. multilocularis and Taenia pisiformis also suggest the possible use of fecal antigens to diagnosis E. multilocularis in dogs and cats.


Circumstantial evidence suggests that E. multilocularis was introduced into the upper North American great plains region during the 20th century, possibly via relocation of infected canid hosts. Similarly, introduction of E. multilocularis on islands in the Japanese archipelago has been linked to importation of foxes during the development of a fur ranching industry. In 1989, E. multilocularis was found in red foxes illegally imported into South Carolina by an animal dealer based in Ohio for the purpose of stocking fox-chasing enclosures. Because evidence links previous spread of E. multilocularis to relocation of canid definitive hosts, a survey for E. multilocularis has been initiated in selected fox-chasing enclosures in the southeastern United States. The survey will include examinations of rodents for larval stages, fox feces for taenid-type eggs, and when possible, foxes for adult parasites. Preliminary results of the survey will be presented.
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INCIDENCE OF ECHINOCOCCUS IN MOROCCO. RECENT OBSERVATIONS OF A PEACE CORP VETERINARIAN AND WHY PRACTITIONERS IN NORTH AMERICA SHOULD BE AWARE OF THIS ZOONOTIC DISEASE.
H. C. LLOYD* ARCADIA, FL 33821

Each week for 14 months in 1989 and 1990 I inspected the slaughter of 200 to 250 sheep and 5 to 10 cattle per day. The incidence of liver flukes in cattle and T. B. and Echinococcus in both cattle and sheep was high.

Evidence of Echinococcus was much higher (80-90%) on farms that used dogs in the herding process. Most farms in Morocco get their meat from home slaughter and feed parts of the offal to their dogs. Echinococcus disease has been reported to be the leading cause of surgery in Morocco.

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ECHINOCOCCUS MULTILOCULARIS INFECTION: AN EMERGING PUBLIC HEALTH PROBLEM. WHAT CAN WE DO ABOUT IT? PETER M. SCHANTZ. CENTERS FOR DISEASE CONTROL. ATLANTA, GA 30333.

Echinococcus multilocularis is capable of causing a very severe disease in humans who accidentally ingest the tapeworm eggs passed in the stools of infected canid hosts. The evidence is now clear that the cestode has expanded its range in central North America and is widespread in foxes, coyotes and several species of rodent intermediate hosts in at least 12 states in the North Central United States. Further spread would appear inevitable and is actually being facilitated by the practice of translocation of wild canids from northern to southern states. The degree to which pet dogs and cats may be infected has not yet been studied. To date there are few instances of zoonotic transmission, however, the prolonged incubation period of human disease means that the problem could become substantial well before we recognize it. This presentation will consider what should be our response to this emerging problem? Laboratory research is providing ever more efficient diagnostic technology that can be applied to the problem. It is important to perform surveys of infection in wild and pet animal populations and to screen for disease in persons who are at greatest risk of infection (e.g., trappers, hunters, wild life biologists). The most important first line of defense is awareness of the problem. Veterinarians must be knowledgeable on diagnosis, treatment and prevention in order to protect themselves and their assistants and because their credibility with pet owners is the most effective way to spread this knowledge to a wider sector of the population. An effective response to this problem will require the cooperative efforts of academic research workers, veterinary practitioners, government agencies and industry.
MECHANISMS OF RESISTANCE OF NEMATODES TO ANTHELMINTICS.
GEORGE A. CONDER.* ANIMAL HEALTH THERAPEUTICS, UPJOHN LABORATORIES, KALAMAZOO, MI 49001.

Resistance to anthelmintics has been reported in nematodes throughout the world, and all major classes of anthelmintics have been shown to elicit resistance in the field. Most reports of resistance involve trichostrongyles in sheep and goats and small strongyles in horses, but recent accounts demonstrate anthelmintic-resistant populations in cattle and swine. Although anthelmintic resistance has developed slower in North America than in other parts of the world, it is a problem of growing concern. Some reports incorrectly blame treatment failure on anthelmintic resistance. Nevertheless, it is clear that significant resistance to anthelmintics is present in the field, that developing resistance is not recognized in a timely manner, and that resistance is increasing. If we are to identify strategies to preserve the utility of existing anthelmintics, we must understand the molecular mechanisms of anthelmintic resistance. At this time, the benzimidazoles, which are generally believed to act as tubulin inhibitors, are the only class of anthelmintics for which we have some knowledge of the mechanism of resistance in nematodes. It appears resistant nematodes have lost high affinity benzimidazole binding sites due to an alteration in their β-tubulin isotype pattern. The change probably is not due to a gene deletion or mutation, as has been reported for the free-living nematode Caenorhabditis elegans and fungi, but rather to drug selection of pre-existing genes.

STRONGYLES IN HORSES-CONTROL OF ANTHELMINTIC RESISTANCE. THOMAS R. KLEI. LOUISIANA STATE UNIVERSITY AGRICULTURAL CENTER AND SCHOOL OF VETERINARY MEDICINE. BATON ROUGE, LA 70803.

Resistance of equine strongyles to anthelmintics is considered to be widespread in North America. Although studies of resistance currently focus on benzimidazole compounds, concern about the potential of resistance to other contemporary anthelmintics has been raised. In the face of these developments a number of different parasite control programs, designed to minimize the selection of drug resistant strongyle populations have been proposed. These are based on published anthelmintic efficacies, and minimal epidemiologic data available from selected regions. These strategies include: continued use of a drug until resistance develops, interval treatment, slow rotation, strategic treatments, and alternative L₃ to chemotherapeutic treatment.

This review will outline the rationale for these strategies, evidence for their efficacy, and potential pitfalls in their implementation. Attempts will be made to suggest suitable control programs taking climatic conditions, management practices and the control of non-strongyle parasite infections into consideration.
TRICHOSTRONGYLES IN SHEEP AND GOATS - CONTROL OF ANTHELMINTIC RESISTANCE. R.M. CORWIN*. UNIVERSITY OF MISSOURI. COLUMBIA, MO 65211.

Apparent anthelmintic (AH) failure in sheep and goats may be due to misdosing, e.g., underdosing; grazing pastures heavily contaminated with infective *Haemonchus* larvae allowing for rapid reinfection; presence of inhibited larval stages not affected by AH such as levamisole or thiabendazole; and presence of an AH resistant population of *Haemonchus* spp.

Control measures for underdosing could be to weigh the heavier animals and treat per label claim on that weight basis; use of pasture management such as weekly grazing on a "clean" smaller pasture and then removal to another "clean" pasture (a modification of intensive rotational grazing); and administration of an AH which is truly larvicidal. Scheduling of treatment will depend upon geographic and seasonal variabilities.

Resistance is a heritable trait of a portion of a population of nematode parasite sp., esp. *Haemonchus*, to continued use of a given AH such as the avermectins and benzimidazoles. Measures for control of AH resistance would be administration of one AH chemical family for a given season and then alternate with a different class the following year and use appropriate deworming strategies such as 3-4 weeks prior to breeding and to lambing or kidding and prior to movement onto a clean pasture with responsiveness to seasonal changes. Monitor epg just prior to and 7 days after AH administration to differentiate true resistance from other factors allowing for nonresponsiveness.

MECHANISMS OF RESISTANCE OF INSECTS TO INSECTICIDES. R.L. BYFORD* AND B.L. CROSBY. NEW MEXICO STATE UNIVERSITY. LAS CRUCES, NM 88003.

Resistance to insecticides has become a problem of critical importance since it threatens our ability to cope with insect pests of agriculture. Resistance to one or more insecticides has been documented in approx. 450 insect and mite species, with costs of resistance estimated in excess of $1 billion annually. A number of studies suggests that there is a combination of biochemical, physiological and behavioral adaptations responsible for the development of insecticide resistance.

Organophosphate and carbamate insecticides usually exhibit a type of resistance involving biochemical processes that detoxify the insecticide by enzymatic activities of esterases, hydrolases, microsomal oxidases and glutathione transferases. The specific mechanism involves a change in the biochemical action of the nerve synaptic acetylcholinesterase (AChE). Insects resistant to pyrethroid and organochlorine insecticides exhibit some metabolic resistance; however, the dominant resistance mechanism is active site insensitivity (*kdr*). This type of resistance involves a modification of the target sites at the sodium channels of the nerve axon.
HORN FLIES ON CATTLE - CONTROL OF INSECTICIDE RESISTANCE. JOHN L. RINER, FERMENTA ANIMAL HEALTH CO., KANSAS CITY, MISSOURI 64153.

The horn fly, Haematobia irritans, has been estimated to cause an annual economic loss of 730 million dollars. Traditional methods of control such as dust bags, backrubbers, dips and sprays were largely replaced with pyrethroid-based ear tags during the 1981-1984 fly seasons. Insecticide ear tags provided tremendous savings to the producer in time, labor and management input. However, their popularity and widespread use lead to problems now recognized as insecticide resistance.

Insecticide ear tags were the first control mechanism which continually pressured horn flies with a uniform level of pesticide. This single control strategy encourages greater selection leading to eventual resistance development. With suspected or confirmed pyrethroid resistance occurring in the major cattle producing states, producers should be encouraged to implement a total approach to horn fly control. A total approach uses insecticide ear tags along with oral larvicides, dust bags, backrubbers and sprays to achieve optimal fly control. Larvicides should be initiated in the spring before flies appear and continued throughout the fly season. Once horn fly populations reach damaging levels, animals should be sprayed with a commercially available insecticide. When the residual activity of the spray diminishes and horn fly populations return to damaging levels, insecticide ear tags should be applied. Tags should be removed at the end of their effective life and supplemented with other control methods such as backrubbers, dust bags and sprays. The challenge is to avoid total reliance on insecticide ear tags. Even with the introduction of new and effective ear tags, they should be integrated with as many other control methods as are economically feasible.

FLEAS ON DOGS AND CATS - CONTROL OF INSECTICIDE RESISTANCE. M.W. Dryden* Department of Laboratory Medicine, Kansas State University, Manhattan, Kansas 66506.

When attempts to control fleas on pets and in the environment fail, the reason most often given is resistance of the fleas to the insecticide. Most of the research concerning insecticide resistance in cat fleas has been conducted using either inbred strains not exposed to insecticides for many generations or flea strains maintained under constant insecticide pressure. At this time, virtually no data exists to substantiate claims of widespread insecticide resistance in cat fleas. While it is probable that some level of resistance does occur in certain populations of fleas, it is more likely that most product failures are due to "false" or "perceived resistance". Inappropriate claims of resistance can be due to several factors including: inappropriate application of environmental products, failure to adequately treat the environment, not treating all flea infested contact animals, adverse environmental exposure to animals treated with residual compounds, and a lack of understanding of basic cat flea biology and ecology. This seminar will present the current information on insecticide resistance in cat fleas and how to control both false and real insecticide resistance in fleas on dogs and cats.
Biochemical studies of GTP-binding proteins in *Trypanosoma cruzi*. Oz, H.S., Wittner, M., Tanowitz, H.B., Manning, D., Bilezikian, J.P. and Morris, S.A. Albert Einstein College of Medicine, Bronx, NY, 10461.

Biochemical events that moderate transformation of *T. cruzi* involve specific responses to external stimuli. We considered the possibility that signal transduction pathways in the parasite may include GTP binding proteins, with properties similar to those found in higher eucaryotes. We determined pertussis toxin (PT)- and cholera toxin (CT)-dependent ADP-ribosylation as well as immunochemical detection of GTP binding proteins in epimastigote (EPI), trypomastigote (TRYP) and amastigote (AMAS) forms of the parasite. PT-catalyzed ADP-ribosylation was observed in a 39-41 KDa region in EPI, less strongly in AMAS and least in TRYP. Identification of PT substrates with antisera directed against a common sequence of the GTP-binding alpha (α) subunits revealed strongest binding in EPI, weaker in AMAS, and absent in TRYP. Whereas antisera to α6 and α2-23 all identified 40 KDa band in EPI and AMAS, only antisera to α12 and α13 bound strongly to a 40 KDa band in TRYP. CT-dependent ADP-ribosylation also demonstrated stage specific characteristics. CT-dependent ADP-ribosylation of a 42 and 44 kDa band was demonstrable in AMAS, in the supernatant only of EPI, and weakly in TRYP. Gs antisera (CT substrate) bound to a 44 kDa band in TRY, AMAST and the supernatant of EPI. The results suggest that *T. cruzi* parasites may possess several distinct forms of GTP-binding proteins that are PT substrates, but their expression may be regulated by the state of differentiation.
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