



VLA PARASITOLOGY GROUP
ANNUAL HORIZON SCANNING REPORT

February 2007

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CONTENTS

Executive summary		3
Introduction		6
Cryptosporidiosis	General	6
	<i>In vitro</i> studies	6
	Infection in cattle	7
	Infection in goats	8
	Infection in pigs	9
	Detection	9
	Zoonotic aspects	10
Trichinellosis	Epidemiology	10
	Transmission	12
	Surveillance techniques	12
	Detection in Europe	12
	Survey in South America	14
	Human Outbreak	14
	Diagnosis	14
	Vaccine	15
Cestodes		16
Ectoparasites	Cattle	16
	Pigs	18
	Sheep	19
Vector borne diseases	Imported ticks	23
	<i>Anaplasma phagocytophilum</i>	23
	Canine babesiosis	24
	Equine piroplasmiasis	25
	VLA surveillance data	25
<i>Fasciola hepatica</i>	Pathology	26
	Molecular biology and diagnostics	26
	Therapeutics	27
	Epidemiology	28
	Vaccinology	28
Parasitic gastro-enteritis	Ecology	28
	Nematode parasite control	29
	Diagnosis by molecular methods	35
	Anthelmintic resistance in sheep	36
	Anthelmintic resistance in cattle	38
	Detection of anthelmintic resistance	38
	Parasite vaccines	39
	Cattle parasites	40
<i>Dicytocaclus viviparous</i>		40
Coccidiosis	Poultry	41
	Alpacas	42
	Wildlife	42
	Cattle	43

Executive summary

This is a summary of a horizon scanning report of 130 peer and non-peer reviewed papers in veterinary parasitology published in 2006, of relevance to the VLA and Defra.

This report addresses and supports five of the six key aims of the Animal Health and Welfare Strategy:

- *Animals kept for food, farming, sport, companionship, entertainment and in zoos are healthy and treated humanely .*
- *Our disease status is amongst the highest in the world and we able to trade our animals and animal products internationally.*
- *The costs of livestock health and welfare are appropriately balanced between industry and the taxpayer.*
- *Consumer value the confidence they have in food produced safely from healthy animals that are well cared for.*
- *Livestock keeping is part of a competitive British farming industry which succeeds by meeting the needs of consumers at home and abroad, producing food safely to high standards of health and welfare.*

In particular, the work of the VLA Parasitology Group, including this report, complements and supports that of the Defra facilitated, industry-led Sustainable Control of Parasites (SCOPS) initiative, which is successfully involving livestock keepers in taking responsibility for the control of parasitic diseases in livestock.

This second, annual review of relevant scientific publications highlights risks to public, animal and environmental health and to sustainable farming from parasitic diseases of animals. It also identifies means by which these risks could be mitigated or managed. Some of these risks and developments are summarised below:

1. Protection of public health

Cryptosporidia spp.

Studies continue investigating this complex genus.

- An easy-to-use method was published this year, which can be applied to field environmental samples to rapidly detect the presence of *Cryptosporidium* spp. parasites and identify their species.

Trichinella sp.

New molecular tools have been used to investigate this genus. It is now composed of two clades, an encapsulated group (five species and three genotypes) and a non-encapsulated one (three species). There have been renewed investigations into the host range of these parasites and their epidemiological features.

- *Trichinella* sp. have been reported in wild boar and foxes in Europe.
- The first outbreak of *Trichinella* sp. in humans due to *Trichinella britovi* infection was reported on the island of Sardinia. The authors state that this raises questions as to the validity of the concept of *Trichinella*-free areas or regions.

Human monocytic and granulocytic (HGE) ehrlichiosis.

- HGE is now recognized as an emerging zoonosis associated with *A. phagocytophilum* infection in both Europe and USA.
- *A. phagocytophilum* is also the causative organism of equine granulocytic ehrlichiosis (EGE) and a study published in 2006 that shows that equine granulocytic ehrlichiosis (EGE), transmitted by *Ixodes ricinus* ticks in the UK can be the direct cause of death in horses and should be taken into consideration in cases of acute and unexplained death in horses at pasture.

2. Disease prevention and control for sustainable development

Parasitic disease can affect sustainability both by production losses leading to reduced returns and by increased costs of control. The increasing presence of resistance to chemical methods of parasite control threatens sustainability of farming further.

- The use of anthelmintics in adult sheep (particularly long-acting products) appears to be associated with an increased risk of anthelmintic resistance occurring. This adds impetus to the Defra supported 'sheep scab initiative' as treatment of adults with long acting macrocyclic lactones is a common way of treating *Psoroptes ovis* infestation.
- Studies continue into alternative control methods of parasitic gastro-enteritis in sheep and ectoparasites in cattle due to concerns about the sustainability of current chemical controls. A number of authors report that combinations of these alternatives, rather than a single method of control, are likely to be used in the future.
- Anthelmintic resistance in cattle parasites was reported at high prevalence in New Zealand.
- Resistance to albendazole and triclabendazole in *Fasciola hepatica* has been described in Spain.
- Resistance to macrocyclic lactones in *Dictyocaulus viviparus* was described in Brazil.

3. Protection and promotion of the welfare of animals

Parasitism of farm animals can directly affect their welfare by increasing suffering (for example, through diarrhoea, pruritis, weight loss and death).

Even in extensive grazing, gastro-intestinal parasites often have to be controlled where ewes are brought together at lambing time for supervision. A

study published in 2006 using a biological control agent (a fungus) fed daily to sheep at these times, was shown to have a significant effect on the infective larvae present on pasture, which could further improve lambs performance. Whether this could have an application in some farming systems in UK is not yet known.

4. Protection of the wider economy, environment and society

A calculation of the major endemic disease of sheep in Great Britain published in 2005 estimated the following annual costs:

- Gastro-intestinal parasitism - £84 million
- Sheep scab due to *Psoroptes ovis* - £8 million.

The use of an ELISA serological test to identify scab infested flocks in Switzerland has raised the possibility of targeting chemo-metaphylaxis and hence decrease the use of endectocides as well as ectocides to control sheep scab. This would be of great benefit in reducing the likelihood of developing anthelmintic resistance, decreasing the extent of environmental and human contamination with potentially toxic products and diminishing potential drug residues in meat and milk.

5. International Animal Health

Equine piroplasmosis

Although autochthonous equine piroplasmosis has not yet been recorded in the UK, the only barrier now seems to be the English Channel. The tick vector *Dermacentor reticulatus* has been historically reported from coastal habitats and commons in the West of England and Wales and more recent studies have demonstrated that it is now more widespread in the south and possibly south east of England. A case of equine piroplasmosis was recorded in Normandy.

Exotic ticks

A case was reported of an imported horse arriving in Germany from Montana, USA (via the Netherlands) that was found to be infested with *Dermacentor albipictus* ticks. *Dermacentor* sp are known vectors of Babesia, Theileria, viruses and Rickettsiae. The tick is known to occur up to 60°N in Canada and it is thought the woods of Northern Europe could also be a suitable habitat. In an outdoor experiment, engorged adult females, collected from the horse, laid eggs, which hatched, to larvae within 25 weeks of engorgement. The authors note that there are no EU regulations or OIE guidelines to prevent the importation of ticks and point out the importance of vigilance in examination of imported animals for ectoparasites and correct identification of species found.

INTRODUCTION.

This is a summary of peer and non-peer reviewed parasitology literature published in 2006. It is not a comprehensive review as it reflects the expertise of the parasitology group members and only contains papers that are considered relevant to the VLA.

Molecular techniques are being used more widely, particularly in parasites that are of zoonotic importance, to elucidate the epidemiology of the genera involved.

Reports of instances of resistance to chemical methods of control continue to be reported in the endoparasites of cattle and sheep. Numerous papers on alternative control methods for parasitic gastro-enteritis in sheep were also published. However there is now the recognition that no one alternative control method will replace modern anthelmintics. The difficulty of translating this into useful control measures for farmers is also discussed.

CRYPTOSPORIDIOSIS

General

Evidence is compiled from a variety of molecular and biological studies to build a convincing case for distancing *Cryptosporidium* species from the coccidia conceptually, biologically and taxonomically. They must no longer be considered as unusual or unique coccidia but as a distantly related lineage of apicomplexan parasites that occupy many of the same ecological niches as coccidia.

Trends in parasitology. Barta, J. and Thompson, R.C.A. 22 (2006) 463-468.

Grace Mulcahy's group in Dublin published a very comprehensive review of *Cryptosporidium* in Ireland. This concluded that the parasite poses a significant threat to both human and animal health.

Zintl et al, Irish Veterinary Journal 59 (2006) 442-447 and 495-500.

***In vitro* studies**

The culture of *Cryptosporidium parvum* in monolayers in epithelial cells is a suitable model to study its interaction with the host cell, to assay oocyst infectivity and to screen drugs for anti-cryptosporidial activity. However the growth of *cryptosporidium* in culture is limited in time and does not lead to the production of large numbers of oocysts, for reasons that are unknown. Many monolayer cells remain uninfected, suggesting that some are less susceptible to infection. In this paper the authors tested whether the dependence of the parasite on host-cell metabolites may favour the infection of cells in mitosis. *C parvum* did indeed show a significant preference for cells in mitosis.

Widmer, G. et al. Parasitology 133 (2006) 131-138

Cryptosporidial infection in cattle

Humans and animals are infected worldwide by apicomplexan parasites of the genus *Cryptosporidium*. Yet, parasitologists are continuously surprised by the expanding complexity of this genus. Over the past 20 years, cattle were identified as being a reservoir host for taxa transmitted from animals to humans. However, a remarkable assemblage of species affects cattle, including both cattle-specific, in addition to a zoonotic species. To clarify species classification, *Cryptosporidium pestis* sp. nov. is proposed for the species formerly recognised as the 'bovine genotype' of *C. parvum*. Slapeta, J. Trends in Parasitology. 22 (2006) 469-474.

Cryptosporidium parvum infects humans and ruminants. *C. parvum* isolated from cattle in north eastern Turkey and in Israel was genotyped using multiple polymorphic genetic markers, and the two populations were compared to assess the effect of cattle husbandry on the parasite's population structure. It was shown that genetically distinct populations of *C. parvum* can emerge within a group of hosts in a relatively short time. This may explain the frequent detection of host-specific genotypes with unknown taxonomic status in surface water and the existence of geographically restricted *C. hominis* genotypes in humans.

Tanriverdi, S. et al. Applied and Environmental Microbiology. 72 (2006) 2507-2513

The authors have previously described a factor in adult rat or adult bovine intestinal mucosa that protects against *C. parvum* infection when fed to susceptible infant rats. This factor is absent in intestinal mucosa from bovine calves. In this present study the active component of bovine intestinal mucosa is further characterized. It was found to be associated with the extrinsic membrane protein fraction. The protein had an N-terminal sequence homology to leucine aminopeptidase.

Akili, D. et al. Veterinary Parasitology 142 (2006) 168-172.

This paper discusses the first genetic confirmation and characterization of *C. andersoni* from cattle in the UK and its sample prevalence within a dairy herd. The incidence, prevalence and possible importance of this parasite in cattle is discussed. Its presence in the UK is probably underestimated due to the lack of overt, acute clinical signs. The potential for zoonotic transmission is unknown. The within-herd prevalence in this study was shown to be 16%. The incidence and spectrum of disease in cattle needs to be better defined. Robinson, G. et al. Veterinary Parasitology 142 (2006) 163-167.

This paper discusses the prominent hyperplasia of abomasal mucosa associated with *C. andersoni* infection in cattle in Japan. Transmission and scanning EM revealed that the morphology of *C. andersoni* was common to that of other *Cryptosporidium* spp.

Masuno, K. et al. Veterinary Pathology 43 (2006) 202-207.

Results of a study into factors associated with shedding of *Cryptosporidium parvum* versus *Cryptosporidium bovis* among dairy cattle in New York State confirm that *C. bovis* infection is typically not associated with diarrhoea in dairy cattle. Animals were significantly more likely to be infected with *C. parvum* than with *C. bovis* if they had diarrhoea at the time of faecal sample collection. This finding lends credence to the theory that *C. bovis* may be more host adapted and thus less pathogenic to dairy cattle than *C. parvum*. Geometric mean oocyst count was significantly higher in animals infected with *C. parvum* than in animals infected with *C. bovis*.

Animals infected with *C. parvum* in the present study had a lower mean age, narrower age range, and lower minimum and maximum ages than did animals infected with *C. bovis*. Mean age of animals infected with *C. parvum* was 13.0 ± 6.2 days and mean age of animals infected with *C. bovis* was 19.8 ± 11.6 days.

Starkey, S.R. et al. JAVMA, 229 (2006) 1623-1626.

On two occasions, the authors identified *Cryptosporidium parvum* with an unusual banding pattern after restriction enzyme digestion of *Cryptosporidium* oocyst wall protein PCR fragments. The samples originated from a single farm with calf diarrhoea. The *Cryptosporidium* oocyst wall protein PCR fragment sequence revealed a point mutation in one of the recognition sites for RsaI. Subgenotyping showed that samples from both samplings shared the same MS1 and GP15 alleles. Analysis of the TP14 microsatellite was less sensitive and results were only obtained from two samples. Both had the same allele. This is, to the author's knowledge, the first description of a *C. parvum* with this *Cryptosporidium* oocysts wall protein genotype. More importantly, the genotype seems to be stable over time since they could detect it again among newborn animals almost 1 year after it was first identified.

Bjorkman, C., Mattsson, J.G. FEMS-Microbiology-Letters. 254 (2006) 71-74.

Cryptosporidial infection in goats

A French team examined the risk factors for *Cryptosporidium* infections in kid goats. They concluded the major factor was the practice of kid grouping by age or weight.

Delafosse et al, Preventive Veterinary Medicine 77 (2006) 109-121.

There was a massive outbreak of watery diarrhoea in kids aged 5-15 days in a goat herd in Gonen District, Isparta Province, Turkey, in May 2003. The presence of *Cryptosporidium parvum* was investigated in the faeces of 130 diarrhoeic kids and three dead kids in this herd. All of the faecal samples were also examined for rotavirus and coronavirus. *C. parvum* was detected in all of the faecal specimens. Coronavirus and rotavirus were not detected in any of the animals. The examination of faecal samples from 20 randomly selected adult goats showed that five samples had low counts of *C. parvum* oocysts. It is suggested that subclinically infected adult goats, insufficient colostrum intake in kids, and contamination of the kidding area may be associated with *C. parvum* infection status.

Sevinc, F; Simsek, A; Uslu, U. Turkish Journal of Veterinary and Animal Sciences. 29 (2005) 1317-1320.

Cryptosporidial infection in pigs

PCR and DNA sequencing detected *Cryptosporidium* spp. in 25 of 56 pig slurry samples from 33 Irish farms. The organisms detected included *C. suis*, *Cryptosporidium* pig genotype II, and *C. muris*. The authors concluded that *Cryptosporidium* oocysts could persist in treated slurry and potentially contaminate surface water through improper discharge or uncontrolled runoff. Xiao, L H. et al. Applied and Environmental Microbiology. 72 (2006) 4461-4463.

Detection

Ghent University Laboratory of Parasitology examined six detection methods for *Cryptosporidium* prevalence in calves and unsurprisingly came to the conclusion that PCRs were the most sensitive. Geurden et al, Veterinary Research 37 (2006), 671-682.

A technique was developed for immunolabelling *Cryptosporidium parvum* oocysts for subsequent observation by transmission electron microscopy. This method was developed to maintain architectural integrity of the oocyst wall and improve fixation of internal contents. The improved fixation and embedding method permitted efficient immunolabelling of both nonexcysted and excysted *C. parvum* oocysts and may be applicable to other oocyst- and cyst-forming protozoa. Jenkins, M. C. et al. Journal of Parasitology 92 (2006) 403-405.

The identification of *Cryptosporidium* species and genotypes is necessary to determine sources of infection in outbreaks and the risk factors associated with their transmission. Few studies have applied isolation methods to field samples because of difficulties with detection of oocysts in environmental samples, particularly in soil and manure. The objective of a study published in 2006 was to develop an easy to use method, which can be applied to field samples to rapidly detect the presence of *Cryptosporidium* parasites and identify their species. The assay included an oocyst recovery method combined with spin column DNA extraction, followed by PCR-hybridization for detection and a real-time PCR-melting curve analysis for species assignment. An internal positive control (IPC) was developed to determine the presence of PCR inhibitory substances. Two oocyst recovery methods, sodium chloride and sucrose flotation techniques were compared. Two commercial DNA extraction kits were performed using faeces, soil and water samples each inoculated with different concentration of *Cryptosporidium* oocysts. Subsequently, methods were used to test field samples. The sucrose flotation method provided the greatest analytical sensitivity detecting as few as 10 oocysts. The PCR-hybridization detection limit was 10 oocysts for faeces and soil, and less than 10 oocysts for water samples. IPC was positive for all inoculated and field samples indicating 0% PCR inhibition. *Cryptosporidium* species DNA samples were detected with the real-time PCR and were

differentiated by the melting curve analysis. The results of this study demonstrate the potential of the assay system for rapid detection of *Cryptosporidium* parasites in environmental samples.

Ramirez, N. E., Sreevatsan, S. *Veterinary Parasitology*. 136 (2006) 201-213.

Zoonoses

In 1992 the World Health Organization (WHO) and Pan-American Health Organization (PAHO) published the outcome of an informal consultation of agents on the epidemiology, biology, molecular genetics, treatment and public health implications of intestinal protozoa. In September 2004, *Giardia* and *Cryptosporidium* were included in the 'Neglected Diseases Initiative'. Major hopes were that molecular methods would generate significant insight into *Giardia* and *Cryptosporidium* biology, epidemiology and host-parasite interactions. Important sources of contamination with cryptosporidial oocysts include sewage discharges and run-off from livestock. Oocysts occur commonly in sewage effluent. Conventional sewage treatment considerably reduces oocysts (reduction of 1-1.5 log units) but large numbers are still discharged into surface waters. Additional sewage treatments (membrane systems, sand filtration systems, disinfection) improve oocyst removal substantially. However sewer overflows bypass sewage treatments. The instigation of the 'Cryptosporidium Regulation' in England and Wales led to the improvement and upgrading of 'high-risk' treatment risks. As a result the percentage of treated water samples containing *Cryptosporidium spp* oocysts has dropped from 8% in 1999 to 1% in 2003. Water utilities worldwide are evaluating UV as an additional barrier to *Cryptosporidium*. Savioli, L. et al. *Trends in parasitology* 22 (2006) 203-208.

The oocysts of *Cryptosporidium spp* are highly resistant to harsh environmental conditions and disinfectants. Two products were tested that contained either formaldehyde or hydrogen peroxide. Two techniques were used to evaluate the *in vitro* viability of oocysts, the inclusion of fluorogenic propidium iodide vital dye, which is an indication of oocyst death, and an excystation technique. Both disinfectants had some anticryptosporidial effects.

Castro-Hermida, J.A. et al. *The Vet Journal* 171 (2006) 340-345.

TRICHINELLOSIS

Epidemiology

The presence of *Trichinella* larvae was investigated in 247 samples taken from domestic, synanthropic and sylvatic animals, collected during 1996 to 2005 in 12 endemic provinces of *Trichinella* infection in Argentina. Muscle larvae of *Trichinella* from 65 infected animals were identified at the species level by single larva nested polymerase chain reaction (PCR) technique based on the variability within the expansion segment V (ESV) region of the

ribosomal DNA. *Trichinella* infections were found in 97 of 164 pigs, 38 of 56 pork products, two domestic dogs, one domestic cat, 7 of 11 armadillos and 3 of 9 synanthropicrats. All *Trichinella* isolates were identified as *Trichinella spiralis* by nested PCR. These findings add new data on the epidemiology of trichinellosis and should be considered when implementing new strategies to control this zoonosis.

Krivokapich S.J. et al. J. Helminthol. (2006) 267-269.

A review was published in which the authors describe the current knowledge on the systematics, ecology and epidemiology of *Trichinella* and trichinellosis, and the impact of recent research discoveries on the understanding of this zoonosis. The epidemiology of this zoonosis has experienced important changes over the past two decades, especially with regard to the importance of the sylvatic cycle and the sylvatic species. Outbreaks of trichinellosis (due to *Trichinella spiralis*) from domestic swine, while still frequent, increasingly are caused by other *Trichinella* spp. infecting hosts such as horses, dogs, wild boars, bears and walruses. The latter revelations have occurred as a result of a series of discoveries on the systematics of *Trichinella* spp., facilitated by new molecular tools. As a consequence, the genus is now composed of two clades, an encapsulated group (five species and three genotypes) and a non-encapsulated one (three species). This has sparked renewed investigations on the host range of these parasites and their epidemiological features. Most dramatic, perhaps, is the recognition that reptiles may also serve as hosts for certain species. This new knowledge base, in addition to having an important relevance for food safety policies and protection measures, is raising important questions on the phylogeny of *Trichinella* spp., the ecological characteristics of the species and their geographic histories.

Pozio, E. Darwin Murrell K. Adv Parasitol. 63 (2006) 367-439.

Herbivorous animals can play a very important role in spreading trichinellosis. In a study published in 2006, the susceptibility and distribution of *Trichinella spiralis* infection was examined in 16 goat kids. The goats were inoculated with 10,000 *T. spiralis* larvae isolated by artificial digestion methods. The animals were necropsied (two animals in weekly intervals) and the larval burdens in different muscle tissue and anti-*Trichinella* antibodies measured with the indirect enzyme-linked immunosorbent assay (ELISA). Serological method using excretory-secretory (E/S) antigen for detecting anti-*Trichinella* antibodies was assessed during the experiment. *T. spiralis* larval burden was maximal at 6 weeks post inoculation and the larvae were also found in the myocardium. In this paper, our next step was to compare the specificity and the time of seroconversion by means of ELISA based on E/S antigen prepared from *T. spiralis*. An antibody response was detected in all 16 goats. The ELISA test carried out showed the first increments in optical density 2 weeks post infection (p.i.) reached their peak 4 weeks p.i. and remained elevated from that day until the end of the experiment (10 weeks p.i.). These results indicated that specific anti-*Trichinella* antibodies in goats persist for a relatively long time.

Korinkova, K. et al. Parasitol Res. 99 (2006) 643-7. Epub 2006 May 20.

Transmission

Congenital transmission of *T. spiralis* infection in BALB/c mice was studied. Pregnant mice were each infected with 300 larvae 5, 7, 15 and 17 days after fertilization. Newborn mice were examined by artificial digestion of muscles. Out of 6 offspring born to the mother-mouse infected 7 days after fertilization, two offspring were found to be infected, 7 and 24 larvae were recovered respectively. Other 7 female mice were first infected with *T. spiralis* larvae and then gestated, only the offspring born to the mother-mice fertilized 8 and 22 days after infection were found to be infected with a larval burden ranging from 1-3 larvae per animal. All of the larvae recovered from the offspring were the non-encapsulated larvae. The cross fostering in which one-day old young born to healthy mother-mice were nursed by infected mothers for 21 days, showed that no young were found to be infected. These findings showed that transplacental transmission of *T. spiralis* could occur in mice, if the female were infected during mid-pregnancy or fertilized in 1 month after infection. The larvae transmitted from maternal-to-neonatal mice may be migrating. Trans-mammary transmission of *T. spiralis* was not observed. Cui J., Wang Z Q., Han H M. *Helminthologia* (Bratislava) 43 (2006) 7-10.

Surveillance Techniques

The use of available technology and its present implementation for the Meat inspection for *Trichinella* in pork, horsemeat and game within the EU was discussed. A new EU directive relating to meat inspection for *Trichinella* imposes important modifications to current legislation. Nevertheless, several issues the authors state need more attention. Optimisation of methods, especially concerning sensitivity and digestibility of the meat to be inspected, along with further simplification of the legislation with regard to the number of techniques accepted, is recommended to guarantee that all member states of the EU will be given tools to perform inspection of consumer meat at the same high level. Additionally, there is a need for guidelines and protocols regarding optimal proficiency testing procedures. This paper presented an overview of the current methods for *Trichinella* meat inspection and their implementation in the EU, listing advantages and disadvantages for each method, including some suggestions for specific points of improvement.

Webster, P. et al. *Euro Surveill.* 11 (2006) 50-55.

Detection in Europe

A wild boar (*Sus scrofa*) from the island Usedom in Mecklenburg-Western Pomerania (northeast Germany) was detected as *Trichinella*-positive during routine meat inspection. Encapsulated and non-encapsulated larvae were detected in the muscle tissue by trichinoscopy. In the diaphragm, 922 larvae per g were detected by artificial digestion. Muscle larvae displayed two different sizes of about 700 and 1100 microm. By a multiplex PCR analysis, larvae with a large size were identified as *Trichinella spiralis*, whereas those of a smaller size were identified as *Trichinella pseudospiralis*. This is the first finding of a mixed infection of *T. spiralis* and *T. pseudospiralis* in a naturally

infected animal and it supports the tendency of more frequent detection of the non-encapsulated species *T. pseudospiralis* in Europe.
Nockler, K. Reckinger, S. Pozio, E. *Veterinary Parasitol.* 137 (2006) 364-368. Epub 2006 Mar 2.

Since 1992, when the European Union Council Directive required that wild boars (*Sus scrofa*) hunted in EU for commercial purpose should be examined for *Trichinella*, the infection has not been detected in wild boars from Belgium, despite serological evidence of the presence of anti-*Trichinella* antibodies in wildlife and previous reports of *Trichinella* larvae in this host species. In November 2004, *Trichinella* larvae were detected in a wild boar hunted near Mettet, Namur province (Southern Belgium). Larvae were identified as *Trichinella britovi* by polymerase chain reaction methods. This is the first report of the identification of *Trichinella* larvae from Belgium at the species level. The detection of *T. britovi* in wildlife in Belgium is consistent with findings of this parasite in other European countries and confirms the need to test game meat for *Trichinella* to prevent its transmission to humans.
Schynts, F. et al. *J.Vet Parasitol.* 135 (2006) 191-194. Epub 2005 Sep 30.

Farming of fur animals represents an important income in Estonia. Even though *Trichinella* worms does not induce a symptomatic disease in carnivores, the carcasses of skinned animals can increase the biomass of the parasite in the environment, if they are not properly destroyed. The aim of the present survey was to study the prevalence of *Trichinella* worms in farmed fur animals of Estonia. Of 281 muscle samples from blue foxes (*Alopex lagopus*), silver foxes (*Vulpes vulpes fulva*), minks (*Mustela vison*) and raccoon dogs (*Nyctereutes procyonoides*), which were collected in eight farms, *Trichinella* larvae have been detected in 21 animals (8%) from two farms by HCl-pepsin digestion. The highest number of larvae per gram of muscle was found in the front limb muscles. Larvae of the 21 isolates have been identified as *Trichinella britovi* or *Trichinella nativa* by a multiplex-PCR analysis.
Miller, I. Jarvis, T. Pozio, E. *Vet Parasitol.* 139 (2006) 140-144. Epub 2006 Mar 27.

A survey of the parasitic fauna of the Norwegian red fox (*Vulpes vulpes*) population was carried out in 1994/1995 and 2002-2005. All foxes were killed during the licensed hunting season from October to April and, in total, 393 animals from all regions of the country were examined. The present study details the results of extra-intestinal nematode and *Trichinella* larvae examinations. All individuals were examined for *Trichinella*, using routine digestion methods. Parasitological examination of the internal organs of some of the foxes also identified a number of different extra-intestinal nematodes. The following prevalence's were identified (number positive/number foxes examined): *Trichinella* larvae 19/393 (4.8%); *Capillaria bohmi* (*C. bohmi*) 88/174 (51%); *Capillaria aerophila* (*C. aerophila*) 160/181 (88%); *Crenosoma vulpis* (*Cr. vulpis*) 105/181 (58%) and *Capillaria plica* (*C. plica*) 81/154 (53%). No evidence of *Angiostrongylus vasorum* infection was found. The 19 different *Trichinella* isolates were species typed by PCR and sequence analysis; 18 isolates were identified as *Trichinella nativa* and one as *Trichinella britovi*. A wide geographical distribution of the parasites was

seen. The following exceptions were recorded: *C. bohmi*, the prevalence of which was significantly lower in northern Norway (6%) compared to other regions (central Norway, eastern Norway and southern and western Norway; 52-57%). There was a significantly higher prevalence of *Trichinella* infection in eastern Norway (8.1%), when compared with the rest of the country (0.6%). *Cr. vulpis* prevalence was significantly higher in central Norway (83%) than in other regions (41-56%). There were no significant differences in age and sex distribution of the parasites with the exception of *Cr. vulpis* where juvenile foxes had a greater likelihood of infection. The data also indicated that adult foxes were more commonly infected with *Trichinella* larvae (5.8%) than juveniles (3.3%) (no statistical significance).

Davidson, R.K. et al. *Vet Parasitol.* 136 (2006) 307-316. Epub 2005 Dec 27.

Survey in South America

Samples of 2,490 adult pigs, slaughtered under federal inspection between May 2004 and February 2005 in the county of Palmas, State of Parana, Brazil, were examined by pooled sample artificial digestion with magnetic stirrer assay for a survey of *Trichinella* spp. larvae. Animals originated from 53 counties in three states of southern Brazil. Test sensitivity was increased with modifications of the European standard for artificial digestion. In this survey, a 5-g sample of tongue and 5-g sample of diaphragm pillar were collected from each pig into a pool of 100 g (up to 10 animals for each assay). A 355-microm mesh sieve was used, but no larvae were detected in the pigs, indicating that trichinellosis does not occur in the examined stocks.

Daguer, H. Bersot Ldos, S. Barcellos, V.C. *J Food Prot.* 69 (2006) 686-688.

Human Outbreak

Trichinella sp. infection has been documented in both humans and animals in most Mediterranean countries, yet in the past 60 years no infections have been reported on the Mediterranean islands. A paper published in 2006 described the first outbreak of *Trichinella* sp. infection to have been reported on the island of Sardinia. The outbreak occurred in two villages in 2005 and involved 11 people who had eaten raw sausages made from the same free-ranging sow. All 11 people developed signs and symptoms of trichinellosis and seroconverted within 48 days of consuming the infected meat. The etiological agent was *Trichinella britovi*. Sardinia, like all Mediterranean islands, had been considered to be *Trichinella*-free. The present report, together with a recent report of *T. britovi* infection in animals on the nearby island of Corsica (France), raises questions as to the validity of the concept of *Trichinella*-free areas or regions.

Pozio, E. et al. *Vet Parasitol.* 140 (2006) 177-180.

Diagnosis

A bulk analysis of inter-simple sequence repeat-polymerase chain reaction (ISSR-PCR) provides a quick, reliable, and highly informative system for DNA banding patterns that permit species identification. This paper evaluated the applicability of this system to *Trichinella* species identification. After a single

amplification carried out on a single larva with the primer 816([CA]_nRY) under high stringency conditions, which provide high reproducibility, the authors were able to identify by consistent banding patterns 5 sibling species: *Trichinella spiralis* (ISS48), 2 *Trichinella britovi* isolates (ISS11 and ISS86), *Trichinella murrelli* (ISS35), *Trichinella nativa* (ISS71), *Trichinella nelsoni* (ISS29); 3 additional *Trichinella* genotypes: T8 (ISS149), T9 (ISS408 and ISS409), and T6 (ISS34); and the nonencapsulated species *Trichinella pseudospiralis* (ISS13). Moreover, 33 new *Trichinella* isolates from 2 zoogeographical regions were unequivocally identified. All *Trichinella* isolates have shown an identical pattern with those produced by the reference strain. According to these data, the authors state that they have demonstrated that ISSR-PCR is a robust technique that emerges as a useful new application for the molecular identification of *Trichinella* isolates in epidemiological studies. Fonseca-Salamanca, F. et al. J Parasitol. 92 (2006) 606-610.

The majority of studies on the immunobiology of *Trichinella* species have centred on the larval muscular phase (L1) with a view to identifying immunodominant antigens located on the surface of the cuticle and in the larval secretions; the nucleus of the parasite-host interaction. These antigens have been classified as eight groups (TSL-1-TSL-8), of which those belonging to the group TSL-1 have been most intensely studied. The principal constituents are glycoproteins, glycan carriers that contain an unusual sugar, the tyvelose (3,6-dideoxy-d-arabinohexose). Studies aimed at improving serodiagnostic techniques to detect trichinellosis indicate that these antigens are ideal candidates. They are capable of inducing a strong humoral response involving the generation of specific antibodies against beta-tyvelose, a sugar that seems to be exclusive to the Trichuroidea. Furthermore, these glycoproteins appear to fulfil an important function in the development and maintenance of the parasite in the muscular niche, and they appear to be fundamental for the invasion of the intestinal epithelium. It has also been demonstrated that specific monoclonal antibodies against tyvelose can mediate a degree of immunoprotection in the rat through the phenomenon known as rapid expulsion.

Bolas-Fernandez, F. Corral Bezara, L. Research in Veterinary Science, 81 (2006) 297-303.

Vaccine

BALB/c and NIH mice have been successfully vaccinated against the intestinal nematode *Trichinella spiralis* by oral administration of crude larval extracts (CLE) and excretory-secretory (ES) products derived from first stage *T. spiralis* larvae (L1) encapsulated in microcapsules made of copolymers of the metacrylic acid (Eudragit L100). Oral vaccination stimulated the secretion of IFN-gamma and inhibited the secretion of IL-4 in spleen and mesenteric lymph nodes (MLN) of BALB/c mice. In vaccinated mice the proportion of CD4⁺ cells increased ($p < 0.05$) in Peyer's patches (PP) and decreased ($p < 0.05$) in spleen whereas the proportion of CD19⁺ cells decreased ($p < 0.05$) in both PP and spleen, with regard to unvaccinated controls. No variation was evident for the proportion of CD8⁺ cells. Oral vaccination elevated the antigen-specific serum IgG1 and IgA ($p < 0.05$) as well as the antigen-specific

IgA response in MLN ($p < 0.05$). It is concluded that this way of vaccination induced concurrent Th1/ Th2 local and systemic responses that are protective and at the same time they may help balancing the strong Th2 response triggered by helminth infections.

Dea-Ayuela, M.A. Rama-In(tilde)iguez ,S. Bolas-Fernandez, F. Vaccine, 24 (2006) 2772-2780.

CESTODES

Eradication of hydatid disease (*Echinococcus granulosus*) from Iceland, Cyprus, New Zealand, Tasmania and the Falklands was described in a paper that reviewed successful parasite eradication programs. Education, treatment of infected dogs and removal of infected viscera from slaughtered animals were all carried out. The possibility of vaccinating animals against *Echinococcus* spp. and twice yearly treatment of dogs has been advocated as another way of eradication. *Taenia solium* is considered a potential for eradication by the author.

Bowman, D.D. Vet Parasitology 139 (2006) 293-307.

The diagnosis of human cystic echinococcus or hydatidosis, caused by *Echinococcus granulosus*, by ultrasound is yielding more information on morphology of cysts. A paper published in 2006 discusses this and how to match this more closely with immunological and cellular events in the disease. Rogan et al. Trends in parasitology 22 (2006) 431-438.

An ELISA test was evaluated for the diagnosis of bovine cysticercosis using heterologous antigens from the larvae of *T. solium* and *T. crassiceps*, by using different types of positive and negative control sera, to allow a broader analysis of the results. The ELISA test showed low sensitivity under natural conditions of bovine cysticercosis manifestation, but high rates (up to 90%) under experimental conditions. The high specificity of the test (81-100%) made evident its capacity to differentiate cysticercosis from other bovine diseases. No difference in performance was found among the antigens studied. It was concluded that the ELISA test has deficiencies in detecting anti-cysticercosis antibodies of animals at slaughterhouse. However, it can be useful in detecting experimentally infected animals and differentiating cysticercosis from other bovine diseases.

Monteiro, L. L., Pinto, P. S. A., Dias, F. S. Veterinary Parasitology 141 (2006) 260-263.

ECTOPARASITES

Cattle ectoparasites

The papers reviewed in this section have involved research on novel treatments, primarily biological treatments against ruminant ectoparasites.

This perhaps reflects concern over the use and the viability of conventional treatment and the lack of funding for other research opportunities within this field.

The entomopathogenic fungus *Metarhizium anisopliae* was considered as a potential biological control agent against the cattle louse, *Bovicola bovis*. It is likely that further research in this area will continue due to the concern over the use of traditional chemicals – resistance issues, possible harmful effects to the environment and to human health. In this paper, the authors looked at the effects of the fungus both *in vitro* and *in vivo*. In the former, lice were immersed in one of three different concentrations of conidial suspension of Tween 80. Controls were subjected to suspension of Tween 80 alone. Following this treatment the lice were incubated in covered sterile wells and monitored for 14 days. Any dead lice were cultured to determine whether they were infected with *M. anisopliae*. More than 80% of the dead treated lice had developed a fungal infection, with no dead control lice infected. With the *in vivo* trial, there were two formulations with lice were placed in six arenas glued to the backs of cattle. This allowed the six possible treatments – Tween 80 or silicone oil as controls or the fungal preparation at 2 differing concentrations in each suspension. Seven days later all recovered lice were removed, killed and cultured for fungal infestation. A significant effect of treatment was noted with no significant difference between infection rates of either formulation. Although promising, eradication of the ectoparasite was not achieved. The authors conclude that the strategic use of a fungal pathogen applied in early winter may be of use in suppressing the parasite population and hence avoid detrimental effects on the host.

Briggs, L.L., Colwell, D.D., Wall, R. *Veterinary Parasitology* 142 (2006) 344-349.

The cattle tick *B. microplus* has serious implications in tropical and sub tropical regions. Due to the difficulty in eradication the maintenance of natural immunity against ticks is important, in order that in endemic areas the economic impact is minimised. This general principle can obviously be extended to ticks in temperate regions such as the UK. The control of ticks is primarily based on chemical control but with establishment of resistant strains alternative control methods are being investigated. In one Brazilian paper the authors looked at the effect of simultaneous use of both chemical and biological acaricides in this case deltamethrin with *M. anisopliae*. The latter is considered a promising biological control agent against ticks. In this *in vitro* study comparisons were made between pyrethroid resistant tick larvae treated singularly with the two agents and simultaneously using multiple replicates at varying concentrations. In all but one case, mortality rates were higher at equivalent concentrations when combined treatment was used. This study supported the hypothesis of a synergistic relationship between chemical and biological products resulting in higher efficacy in treatment of some chemical – resistant arthropods.

Bahiense, T.C., Fernandes, E.K.K., Bittencourt, V.R., *Veterinary Parasitology* 141(2006) 319-324.

The use of a recombinant baculovirus expressing a chitinase from the hard tick *Haemaphysalis longicornis* and its potential application as a bioacaricide for tick control was published. The study confirmed that the recombinant virus was effective at killing ticks. In addition, its use with the pyrethroid flumethrin was assessed with favourable results. The authors observed a synergistic effect allowing the pyrethroid to be used at half its previous concentration with a relative increase in the speed of kill. The authors reported on the potential for the use of the recombinant virus as a biological acaricide, which could be used alone as a replacement for chemical treatment.

Assenga, S.P. et al. Parasitology Research 98 (2006) 111-118.

The effects of the novel macrocyclic lactone, Spinosad, was compared with cyfluthrin (pyrethroid) pour on and coumaphos (OP) topical spray against natural infestations of the chewing louse *B. bovis* and the cattle sucking lice *L. vituli*, *S. capillatus* and *H. eurysternus*. Spinosad is a neurotoxic compound produced by fermentation of the naturally occurring soil bacterium *Saccaropolyspora spinosa* with low toxicity to mammals and birds. The *Haematopinus* burden was conceded as low and the study revealed that Spinosad treatment allowed >-96% control of *B bovis* for up to 7 weeks; >-98% control of *L.vituli* for 5 weeks with 100% control against the other species for at least 6 weeks. Spinosad compared well with the other products having the best therapeutic and residual control against *L.vituli*.

White, W.H. et al. Veterinary Parasitology 143(2007) 329-336.

Pig Ectoparasites.

Sarcoptic Mange

Diagnosis

In a closed pig breeding and finishing herd suffering from sarcoptic mange, two selected groups of pigs were filmed during a period of 10 days before and after treatment. Observations always commenced each hour and lasted for 15 minutes. Before treatment observations were carried out round the clock, after treatment observations were carried out between 08.00 and 22.15hrs. Before treatment the pens were stocked with 11 (Pen A) and 10 (Pen B) growing pigs (Large White X Landrace sows, 5 months old) with an average weight of 70 kg examined for sarcoptic mange by skin scraping and ELISA. The animals had never been treated with an acaricide or endectocide before. After 10 days the pigs were treated twice (18 day intervals) with Dectomax (1% doramectin) for pigs at a dose rate of 0.3mg doramectin i.m/kg body weight. After treatment seven pigs were observed in both pens. Most scratching episodes both before (83.1%) and after (94.5%) treatment were 1 to 10 seconds. After treatment the 10 second scratching episodes decreased by 67.3% (from 21.2 to 6.9 mean SRE/pig), and the scratching episodes of longer than 10 seconds by 91.7% (from 4.3 to 0.4 mean SRE/pig), such that the latter could only be observed only occasionally after treatment. A distinct increase in scratching activity both before and after treatment could be observed primarily between

10.00hr and 15.00hr. Significant differences of rubbing and scratching activity between before and after treatment could also be seen at midday. The interpretation of the scratching index values before and after treatment were carried out according to Cargill et al (1994) and the maximum and minimal limiting values specified in the literature and compared with calculations using methods described by Hollanders et al (1995). Depending on the methods used and the limiting values set, 6.7 – 34.6% of the observations before and 2.0 – 17.3% of the observations after treatment revealed a “strong evidence of mange” or a “suspicion of mange”. All other observations indicated that the pigs were free from mange.

Loewenstein, M., Ludin, A and Schuh, M. *Veterinary Parasitology*, 140 (2006). 334 – 343.

Pathology/Immunology

Although the inflammatory response to *Sarcoptes scabiei* and its antigens is known to cause the main pathology in an infestation, little work has been carried out on this response at the site of infection. This report presents an initial analysis of proteins found in skin scrapings and their antigenic responsiveness in pigs. Skin scrapings and mite extracts were isolated from chronically infected sows while infected and uninfected sera were isolated from pigs with confirmed infections or mange free pigs, respectively. Electrophoresis and sequencing confirmed the main components of both the skin and the mite extracts to be serum proteins. Immunoblotting then suggested that transferrin was the major antigen recognised by pooled infected sera in the skin and the mite extracts. Immunoassays confirmed that a majority of infected pigs produced antibodies to transferrin while mange free pigs did not. A pool of IgG from dogs infected with scabies was then used to isolate another antigen from pig skin scrapings, which was shown to be haptoglobin. This was also shown to induce high titres of antibody in infected pigs as compared to mange free pigs. The use of albumin as a control antigen showed no reactivity in either group of sera. The finding of two iron binding molecules as strong auto-antigens in pig scabies has implications for the importance of iron during this infection and may help to explain the persistence and magnitude of the host inflammatory response.

Zalunardo, M., Cargill, C.F and Sandeman, R.M. *International Journal for Parasitology*. 36 (2006) 1133-1141.

Sheep Ectoparasites

Sheep Scab.

Taxonomy

The taxonomic priority in *Psoroptes* mange mites (Acari: Psoroptidae) was reviewed and the original species descriptions re-examined. The question whether the name *Psoroptes equi* or *Psoroptes ovis* has priority has importance with respect to the descriptions used in legislation required for compulsory treatment of infested animals. It is concluded that the work of Hering (1838), who is generally assumed to present the type description, the

first *Psoroptes* mite described is *P.ovis* and that *P.ovis* should therefore carry taxonomic priority for the synonymised genus.

Wall, R and Kolbe, K (2006). *Experimental and Applied Acarology*. 39: 159-162.

Pathology/Immunology

Infestations of *Psoroptes ovis* result in profound intradermal inflammatory response with generation of IgE and IgG antibodies. *P.ovis* antigens have therefore been implicated in the development of the pathology and or development of immunity to infection and may also offer new candidates for novel therapies including vaccine production. Expressed Sequence Tag (EST) analysis has shown the presence of transcripts encoding several proteins with close homology to *Dermatophagoides pteronyssinus* house dust mite (HDM) allergens. In addition, proteomic and Western blotting analyses, using sera from hyperimmune sheep, or specific antibodies to HD allergens Der p 10 (tropomyosin) and Der P 11 (paramyosin), have provided firm evidence for the presence, and immunodominance, of these allergens in extracts of *Psoroptes* mites. cDNAs encoding tropomyosin and paramyosin were amplified from RNA extracted from *P.ovis*. The tropomyosin cDNA contained an open reading frame (ORF) of 852 bp which encoded a predicted protein with 98% and 97% identity to the *D pteronyssinus* allergens Der f 10 and Der p 10 respectively. The complete paramyosin ORF generated by RT-PCR was 2625 bp in length and coded an 875aa predicted protein of 102.6 kDa with 97%, 95% and 89% identity to the paramyosins of *D pteronyssinus* (Der p 11), *Sarcoptes scabiei* and *Blomia tropicalis* (Blo t 11) respectively. Full length tropomyosin and truncated and full length paramyosin were expressed as recombinant proteins. IgE and IgG in sera from sheep with a 6 week duration primary infestation of *P.ovis* did not detect either full length or truncated recombinant paramyosin. IgG in both infested and naïve sheep sera detected recombinant tropomyosin, suggesting cross reactivity to tropomyosin and to other invertebrate species to which the sheep may have been exposed. Staining with antibodies directed against tropomyosin and paramyosin was observed throughout sections of *P.ovis*. Staining was especially prevalent in the anterior sections of the mites, possibly associated with locomotory muscles in this region.

Nisbet, A.J., et al. *Parasitology*. 133(2006) 515-523.

Diagnosis

A study was carried out by the University of Zurich to attempt to identify scab infested sheep in the Canton of Schwyz by serologically testing (by ELISA) in 2001 and 2002 (587 and 565 flocks respectively). In 2003 a representative number of flocks (182 of the 531) was again investigated. Seropositive flocks were treated with doramectin (0.3 mg/kg body weight i.m) from 2001 to 2003. In spring 2002 no chemo-metaphylaxis was given to sero-negative flocks before movement onto common alpine pastures. Of the 587 flocks surveyed in Spring 2001, 34 were seropositive (5.8%). These consisted of 21 infested with *Psoroptes ovis*, 1 with *P.cuniculi*, 4 with *Chorioptes* spp. and 8 of seropositivity unknown. There was a decrease in seropositive flocks in spring

2002 (4.4% with 15, 0, 2 and 8 respectively. Of the 182 flocks surveyed in spring 2003, just 4 flocks (2.2%) were seropositive. All the seropositive reactions in these flocks were the result of *Chorioptes* spp infestations. There was a corresponding decrease in the proportion of seropositive animals from 6.3% in spring 2001 to 2.1% in spring 2003. These results corroborate the concept that it may be possible to target chemo-metaphylaxis and hence decrease the use of endectocides as well as ectocides to control sheep scab. This would be of great benefit in reducing the likelihood of developing anthelmintic resistance against avermectins, decreasing the extent of environmental and human contamination with potentially toxic products and diminishing potential drug residues in meat and milk.

Jacober, Ph., et al. Veterinary Parasitology. 136 (2006) 373-378.

Control

Studies carried out by the University of Liege, Belgium evaluated an indigenous strain of (IHEM 18747) of the entomopathogenic fungi, *Beauveria bassiana* for its *in vitro* activity against *Psoroptes ovis* (cultured in rabbits). The following aspects were evaluated: a) effects of conidial concentrations on the viability of adult female mites b) influence of infection on the fertility and hatchability of eggs and c) transmission of infection between mites and contaminated surfaces. Adult mites immersed in increasing concentrations of conidia (10^4 – 10^9 conidia per ml) showed a dose related susceptibility. At the highest concentration of conidia, LT_{50} was 1.6 days while LT_{50} for the controls reached 5.8 days. The fungus was able to sporulate on the body surface and 100% of the mites were covered in mycelium after immersion in solutions containing 10^4 – 10^9 conidia per ml). 100% of healthy mites exposed to infected cadavers or surfaces acquired the infection (LT_{50} reached 1.9 and 1.73 days respectively, versus 6.1 and 5.1 days in controls, respectively). Egg laying was not reduced by the fungal infection but both the hatchability of the eggs and the life span of the emerging larvae were significantly reduced. Eggs directly affected by the fungus did not show reduced hatchability but the lifespan of the larvae was shortened. The study concluded that *B. bassiana* has a high entomopathogenic activity against *Psoroptes* spp.

Lekimme, M., et al. Veterinary Parasitology. 139 (2006) 196 – 202.

Chewing Lice (*Bovicola ovis*)

Control

Spinosad, applied as a jetting solution or dip was shown to be an efficacious, non-systemic treatment for the control of chewing lice (*Bovicola ovis*) on sheep. In a dose titration study 0.4mg/kg liveweight dose was found to be the suboptimal dose for the control of *B.ovis* and was used to investigate application and housing effects in a second study. Infested Merino sheep were treated with a narrow (3cm) application of Spinosad or a wider (25cm) swathe. After treatment they were either kept alone or in groups of 6 per pen. Numbers of *B.ovis* were counted on Day 0 and every 14 days until 70 days following treatment before estimation of the percentage of lice control and

analysis of treatment effects. A much higher percentage of lice control was achieved with 0.4 mg/kg in the second study than the first, due to the differences in formulation used. The wider application width gave significantly higher ($p < 0.05$) control of lice than the narrow application when sheep were either housed alone or in groups up to day 42 post treatment. Greater control of lice was seen in group-housed sheep compared with sheep housed individually ($P < 0.05$) up to day 70. Using broader application widths combined with holding the animals together after treatment with pour-on formulations may optimise the delivery and efficacy of ectoparasiticides for livestock.

Lowe, L.B. et al. Australian Journal of Experimental Agriculture. 46(2006) 857-861.

Oestrus ovis

Diagnosis

A study carried out by the University of Thessaloniki and Ecole Nationale Veterinaire de Toulouse compared the host preference of adult *Oestrus ovis* *O. ovis* between sheep and goats in mixed flocks, kept together under the same husbandry conditions and hence, are very similarly exposed to fly preference. Sera were collected from a total of 397 sheep and 335 goats, from 43 mixed flocks located at different regions of Greece. Antibodies specific to *O. ovis* IgG were measured by ELISA. A flock was considered when at least one individual was positive, i.e. showed a seropositivity of $\geq 20\%$ in relation to positive control sera. A total of 193 (48.6%) sheep and 58 (17.9%) goats were found to be seropositive against *O. ovis*. Thirty-eight (88.4%) out of 43 flocks had at least one seropositive animal. The mean seroconversion against *O. ovis* in animals from the different flocks was 38.6% and 13.6% for sheep and goats respectively, whereas the variance of infection within each flock was 0–100%. The mean seropositivity between sheep that were found to be positive or negative was 60.6% and 5.4% respectively, whereas the corresponding values between goats were 35.2% and 5.2% respectively. No significant difference in seroconversion values was noted between flocks from different areas ($P = 0.817$), whereas a very significant difference was observed between animal species ($P = 0.001$). However, there was no significant differences when seroconversion comparisons were made within samples of the same animals species, sheep or goats from different flocks of all the regions included in the study ($P = 0.695$).

Papadopoulos, E., et al. Veterinary Parasitology. 138 (2006) 382-385.

Interaction with *Trichostrongylus colubriformis*

A study carried out by the Ecole Nationale Veterinaire de Toulouse determined if an earlier infection with *Oestrus ovis* would down-regulate an infection with *Trichostrongylus colubriformis* when the larvae of *O. ovis* were expelled from the nasal cavities of sheep by a specific treatment. Three groups of five lambs were used: Group 1 was artificially infested with *O. ovis* larvae and later with *T. colubriformis*; Group 2 received *O. ovis* and was later treated with ivermectin 14 days before being infected with *T. colubriformis* and

Group 3 was infected with *T. colubriformis* only. The criteria examined were: the effects on nematode egg excretion worm fecundity, nematode burdens and the kinetics of blood eosinophils. Significant decreases in nematode egg excretion, worm fecundity, nematode burdens were observed in Group 1 compared to Group 3. However, no changes were observed in either Group 2 or 3. In Group 2 it was noted that anti-parasitic treatment induced a rapid decrease in blood eosinophils to a range close to the non-infected control group and this was associated with the removal of the down-regulation effects of nematode burdens. This study demonstrated that there is no cross immunity between *O. ovis* and *T. colubriformis* and that eosinophils may act against any parasite without specific priming.
Yacob, H.T., et al. Veterinary Parasitology, 137(2006) 184 – 188.

VECTOR BORNE DISEASES

Dangers of importation of ticks on animals

An actual case report about the danger of tick distribution caused by human activities: Importation of the tick species *Dermacentor albipictus* with a horse from the USA into Germany.

The authors report the case of an imported horse arriving in Germany via Amsterdam airport from Montana, USA that was found to be infested with *Dermacentor albipictus* ticks. This species, known as “the winter tick” is a one host tick found on large animal hosts such as horses, cattle, Moose and deer in North America. *Dermacentor* sp are known vectors of Babesia, Theileria, viruses and Rickettsiae. The tick is known to occur up to 60° N in Canada and it is thought that woodland habitats in Northern Europe may indeed be a suitable habitat for establishing a population. For the first four days after arrival more than 200 engorged ticks were removed or dropped from the horse, most of which were destroyed. However in an outdoor experiment, engorged adult females, collected from the horse, laid eggs, which hatched, to larvae within 25 weeks of engorgement. The authors also note that there are no EU regulations or OIE guidelines to prevent the importation of ticks and point out the importance of vigilance in examination of imported animals for ectoparasites and correct identification of species found.

Liebisch, et al. Praktische Tierarzt 87 (2006) 874.

Anaplasma phagocytophilum

To investigate the reservoir tissues of the tick-borne bacterium *Anaplasma phagocytophilum* in persistently infected sheep, six 6-month-old lambs were infected with a field isolate and maintained under tick-free conditions. At one and two weeks post-infection, *A. phagocytophilum* was detected in the peripheral blood of all lambs by examining Giemsa-stained blood smears for classical intra-neutrophil inclusions, and by an *A. phagocytophilum*-specific nested PCR. After euthanasia at 3 months post-inoculation, peripheral blood and numerous tissue samples were collected from each lamb. All blood

samples were PCR-negative but three lambs had PCR-positive tissues including intestinal wall and associated lymph nodes, thymus, bone marrow, kidney and bladder wall. The widespread nature of PCR-positive tissues suggests that circulatory cells may form the reservoir cells for *A. phagocytophilum* infection in carrier sheep, rather than lymphoid tissues as in rodents. PCR-positive tissue and blood samples were strikingly fewer in the experimentally infected sheep than reported earlier in tick-exposed carrier sheep under field conditions. The authors conclude it is possible that tick infestation amplifies *A. phagocytophilum* infections in carrier sheep to a degree that enables tick transmission to occur.
Stuen, S. et al. J.Comp.Path. 134 (2006) 101-104.

A 19 year old horse, that was one of a group of six horses infected experimentally with *Anaplasma phagocytophilum* in a study of the pathogenesis of equine granulocytic ehrlichiosis (EGE), died suddenly two days after first showing clinical signs of disease. The horse developed a fever of 40.8°C with slight depression and moderate reduction in feed uptake six days after infection. The following day it developed an intermittent hind limb ataxia and these signs were similar to those seen in the other five horses. On the morning of the eighth day the horse was found dead in its box. Post mortem examination revealed petechial bleeding and ecchymoses within the nasal cavity and sinuses and massive intramuscular and subcutaneous haemorrhaging in the neck region and over the left shoulder. There was moderate oedema of the prepuce, 0.5 litres of free blood was observed in the thoracic cavity and petechial haemorrhaging in the heart, lungs, liver spleen and kidneys. The most prominent microscopic lesions were found in the kidneys with congestion of glomeruli and necrotizing inflammation of blood vessels. Bacteriological examinations of various tissues were negative. *A. phagocytophilum* is rarely seen in cells and tissues other than in neutrophils and it is possible that damage may be host mediated via neutrophilic mediators or enzymes rather than by the organism itself. Although not commonly observed, consumptive coagulopathy and disseminative intravascular coagulation have been observed in both human monocytic and granulocytic (HGE) ehrlichiosis. HGE is now recognized as an emerging zoonosis associated with *A. phagocytophilum* infection in both Europe and USA. This study shows that EGE, transmitted by *Ixodes ricinus* ticks in the UK can be the direct cause of death in horses and should be taken into consideration in cases of acute and unexplained death in horses at pasture.
Franzen, P. et al. Veterinary Record 160 (2007) 122 – 125.

Canine Babesiosis

Further evidence for the northward drift of canine babesiosis in Europe was provided by a paper describing the autochthonous infection of a four year old mixed breed female dog with *Babesia canis* in Northern Germany. Diagnosis was based on evidence of large babesia in the erythrocytes of a dog, which was subsequently found to have never left North Germany. The dog showed a severe peracute to acute illness and eventually died. Endemic foci of *Babesia canis* are found in some regions of South Germany however until this case, there have been no reports of autochthonous canine Babesia infections in

Northern Germany. Beside the case description an overview is given of clinical signs, pathogenesis, diagnosis, therapy and prophylaxis of canine babesiosis.

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ISBN/ISSN 1434-1239

Publisher Schattauer Gmbh-Verlag Medizin Naturwissenschaften, Holderlinstrasse 3, D-70174 Stuttgart, Germany

Equine piroplasmosis

Although autochthonous equine piroplasmosis has not yet been recorded in the UK, the following report serves as warning that the only barrier now seems to be the English Channel. The tick vector *Dermacentor reticulatus* has been historically reported from coastal habitats and commons in the West of England and Wales and more recent studies have demonstrated that it is now more widespread in the south and possibly south east of England (Alison Dicker, MSc Veterinary Parasitology, Liverpool School of Tropical Medicine 2005).

A literature overview of equine piroplasmosis as a cause of acute babesiosis in a Dutch standard bred foal after visiting a stud in Normandy. Piroplasmosis, a disease endemic to most tropical and subtropical areas, appears to be spreading to more temperate zones. This article gives a review of equine piroplasmosis and describes an acute case of infection with *Babesia caballi* in a Dutch Standard bred foal after a short stay at a stud in Normandy (France). A 3-month-old stallion foal was presented with lethargy, fever and pale mucosal membranes. Haematology revealed a low packed cell volume, leucocytosis and a high blood nitrogen concentration. Infection with *B. caballi* was diagnosed on the basis of Giemsa stained blood smears and was confirmed by polymerase chain reaction (PCR) in combination with reverse line blot (RLB). Treatment with imidocarb dipropionate and a blood transfusion resolved the haemolytic crisis.

Butler, C.M. Tijdschrift Voor Diergeneeskunde 130 (2005) 726-731.

VLA surveillance reports

Tick borne diseases (TBD) have been regularly noted in the monthly VLA surveillance reports between May and December during 2006. Feeding activity of *Ixodes ricinus* ticks and subsequent tick transmitted infections in cattle and sheep in UK are historically reported in two periods during early spring and from late summer through the autumn period and into early November. Recent mild winters seem to prolong the active feeding period of the tick during the latter half of the year and TBD are being more frequently reported at this time. Louping ill (LIV) cases, in sheep and cattle, and redwater fever (*Babesia divergens*) cases in cattle have been regularly reported by regional laboratories in the West country and Wales and VLA Carmarthen have noted that LIV cases are becoming more prevalent in the area and increasing concern has been expressed amongst local farmers. Uncommonly, clinical disease associated with *Anaplasma (Eperythrozoon)*

wenyoni infections has been reported in cattle from both VLA Newcastle and Langford. Vectors of bovine eperythrozoonosis include *Stomoxys calcitrans* (stable flies) and Tabanid flies and clinical disease is rarely reported.

Fasciola hepatica

Pathology

Dutch clinicians described bacillary haemoglobinuria in an adult dairy cow at 5 months gestation. She showed signs of brown urine, dysentery, milk drop and lethargy. The cow had been purchased in Somerset and exported to Holland. The animal had generalised jaundice and a 5 cm diameter yellow necrotic infarct in the liver. Diagnosis was made by serum ELISA, and FAT demonstrating the causal organism *Clostridium novyi* type D (*Clostridium haemolyticum*).

Vine, N., Fayers, J., Harwood, D. Veterinary Record. 159 (2006) 160

Molecular Biology and Diagnostics

A paper by Dutch workers examined the immunoglobulin isotypes produced in cattle chronically infected with either *Fasciola hepatica* or *Fasciola gigantica*. In both sheep and cattle there was an early rise in IgM antibody 2 weeks post infection. The dominant isotype was IgG1; IgG2 was also produced in sheep as early as 2 weeks post infection. In cattle there was a later and stronger IgG2 response to both fluke species. The IgG1 isotype response in sheep and cattle suggested an associated TH2 response. The late IgG2 surge seen in cattle also suggested the possible late involvement of a TH1 bovine cellular response to *Fasciola* excretory protein.

Phiri, I. K., Phiri, A.M., Harrison, L. J. S. Veterinary Parasitology. 141 (2006) 234-242

A Ph.D. thesis by a Polish worker described the occurrence of *Fasciola hepatica* in regions of Poland, detected by molecular and serological techniques. The molecular technique was the use of a PCR test to detect *Fasciola hepatica* DNA in the intermediate and definitive host. The PCR DNA portion could be detected in intermediate host within 12 hours of exposure to fluke miracidia. He also used an ELISA where the recombinant cysteine protease antigen was grown up in *E.coli* culture. He described a greater sensitivity and specificity with this ELISA compared to native excretory-secretory antigens. The prevalence of disease in Poland was greater in central and eastern Poland.

The occurrence of *Fasciola hepatica* in chosen regions of Poland based on molecular and serological methods.

Kozak-Cieszczyk, M. Badania nad występowaniem *Fasciola hepatica* na wybranych obszarach Polski w oparciu o metody molekularne i serologiczne.

A further Dutch paper described the use of a PCR test to detect *Fasciola hepatica* infection in field collected *Lymnaea columella* and *Lymnaea viatrix*

snails. Rates of infection in the two species were described, and the test was described as being effective in detecting low intensity infection in the intermediate host in different areas, and thereby describing the epidemiology of disease in these areas.

Cucher, M.A. et al. *Veterinary Parasitology* 137 (2006) 74-82.

The suitability of an ELISA using a recombinant protein for early diagnosis of ovine fasciolosis was described in a Spanish paper. This test was compared to an antigen ELISA detecting excretory-secretory protein of *Fasciola hepatica* in serum. The antibody ELISA levels remained high whereas the antigen in serum diminished after 6 weeks post infection.

Arias, M. et al. *Veterinary Parasitology*. 137 (2006) 67-73.

A French paper described the differentiation of cattle and sheep originated *F. hepatica* by a PCR method. Genetic variations of *F. hepatica* were seen between the species.

Aldemr, O.S. *Revue de Medecine Veterinaire*.157 (2006) 65-67.

Egyptian workers used a PCR test to detect molecular polymorphism in *F. hepatica* strains from Egypt, Europe and China. All PCR sequences from Egyptian isolates were identical, and they were similar for the European and Chinese isolates. There was however greater polymorphism between isolates from North America.

Tawab, A.H.A., El-Garhy, M.F., Heckmann, R.A. *Journal of the Egyptian Society of Parasitology*. 36 (2006) 389-396.

Therapeutics

Queen's University, Belfast have a strong tradition in research on fasciolosis. One paper described the morphological effects of a combination of triclabendazole and clorsulon, *in vitro*, on mature flukes. There was disruption of the fluke tegument, measured by scanning electron microscopy. The result suggested that there was an additive effect between the 2 flukicides indicating synergy. The combination may therefore be useful as a therapeutic combination in outbreaks of clinical disease.

Meaney, M. et al. *Parasitology Research*. 99 (2006) 609-621.

A paper by Spanish workers described resistance of *F. hepatica* to triclabendazole, clorsulon and albendazole in sheep in Spain. This was a field investigation carried out in commercial sheep in northwest Spain. There was a suspicion of development of flukicide resistance in this region. Faecal egg counts were carried on the day of treatment and 6, 16 and 30 days post treatment. The efficacy of albendazole was very low on day 6 (54%). The efficacy of triclabendazole and clorsulon were both greater at 95.7 and 85.4% respectively. The efficacy of triclabendazole was found to be low at 16 and 30 days post treatment and the efficacy of clorsulon was found to be as expected at 30 days post treatment. They concluded that this was first description of resistance to albendazole and triclabendazole in Spain.

Alvarez-Sanchez, M.A. et al. *Veterinary Record*. 159 (2006) 424-425.

Epidemiology

The distribution of *Fasciola hepatica* in Queensland, following the introduction of 2 new intermediate snail hosts was estimated by Australian workers. Over 5,000 cattle were blood sampled for antibody ELISA, as well as 523 milk samples for antibody ELISA. *Fasciola hepatica* infection was detected in 44 dairy herds and 2 beef herds. Infection was established in southeast Queensland and they concluded that the introduction of the 2 new intermediate snail host species has not yet had a major impact on distribution of the parasite in Queensland.

Molloy, J.B., Anderson, G.R. *Veterinary Parasitology*. 137(2006) 62-66.

A Swiss paper estimated the prevalence of *Fasciola hepatica* in cattle slaughtered in Switzerland, in the absence of a definitive diagnostic test. 1,331 cattle were tested at 2 abattoirs by faecal egg count and serum antibody ELISA. Livers rejected at slaughter were also dissected. The true prevalence of *Fasciola hepatica* was estimated at 18%. The diagnostic specificity of the ELISA was estimated at 93%, and the faecal egg count at 69%.

Rapsch, C. et al. *International Journal for Parasitology*. 36 (2006) 1153-1158

An Irish survey of the prevalence and intensity of gastrointestinal nematode, lungworm and liver fluke infection in culled cows in Ireland was reported. The prevalence of liver fluke infection was put at 65% of all livers examined. The prevalence of lungworm infection was put at 14% based on larval identification in faeces. The examination of abomasums revealed 57% of cows infected in the summer. In all 30 to 68 culled beef or dairy cows were examined during the autumn of 2002 and summer of 2003. The paper concluded that a number of cows showed poly parasitism and that adult animals should be considered in preventative approaches to bovine helminthiasis.

Murphy, T.M., et al. *Preventive Veterinary Medicine*. 76 (2006) 1-10.

Vaccinology

A group working on *Fasciola hepatica* vaccines tested a DNA vaccine in sheep. They found that with their DNA vaccine there was good induction of humoral and cell mediated responses in sheep.

Kennedy, N.J. et al. *Vaccine*. 24 (2006) 970-979.

PARASITIC GASTRO-ENTERITIS

A recent issue of *Veterinary Clinics of North America* provides a review of ruminant parasitology in the USA.

Veterinary Clinics of North America-Food Animal Practice. 22 (2006) Iss3, 507-712

Ecology

The understanding of environmental influences on the free-living stages of *Haemonchus contortus*, *Teladorsagia circumcincta* and *Trichostrongylus* spp. was reviewed.

Temperature and moisture are the dominant influences on the free-living stages of these parasites, with the effects of pasture conditions playing a significant modulating role. Early in the free-living phase, the developmental success of these three species is limited by susceptibility to cold temperatures. In general, *H. contortus* is most susceptible, followed by *T. colubriformis* and then *T. circumcincta*. The length of the development cycle is dependent largely on temperature, with development rate increasing at warmer temperatures. However, in order for development to proceed to the infective larval stage, addition of moisture is generally required. There has been considerably less work quantifying the effects of moisture on free-living development, although it is clear that *H. contortus* is most susceptible to desiccation during the pre-infective stages. Once the infective stage is reached, the influences of temperature and moisture on survival are less important, resulting in considerable survival times under conditions lethal to pre-infective stages. However, hot, dry conditions can be lethal for infective larvae of all three species, while extreme cold is also lethal with significant species variation.

Confounding the effects of environmental variables on development to infective stage is the migration of larvae from the faeces and subsequent survival on pasture.

This information is important in the development of mathematical models describing the epidemiology of PGE and is a key to the development of integrated pasture management systems minimising the use of anthelmintics O'Connor, L. J. et al. *Vet Parasitology* 142 (2006) 1-15.

Nematode parasite control-general

The problems of selling 'complicated' sustainable parasite control management systems to farmers to allow production to continue and slow development of anthelmintic resistance in various countries in the world were discussed in three review papers. Interestingly, all agree that simple systems are likely to result in greater compliance. Expert advice to the farmers is also necessary in a world where government funding is highly unlikely and there is a reduction in suitably qualified parasitologists. Further research into alternatives to anthelmintics, their use in an integrated way with other methods of parasite control and access to useful and accurate advice was considered necessary.

The balancing of drug applications with the maintenance of refugia, to delay the accumulation of anthelmintic resistance alleles in worm populations, while still providing good levels of control was deemed very important. The use of targeted treatments, with selection of animals to be treated aided by the development of the FAMACHA© system for clinical evaluation of anaemia due to haemonchosis and the use of milk yields as an effective indicator in dairy goats infected predominantly with nematodes other than *Haemonchus*

contortus. In addition, short-term weight changes and perhaps also body condition scoring may provide indices of parasitism in other animals, permitting the rapid identification of animals likely to benefit from treatment. The development of computer-based decision support programs, which use epidemiological, seasonal and clinical information to provide recommendations for specific situations, it is advised, should be accorded high priority in the future development of worm management systems.

Jackson, F. and Miller, J. *Veterinary Parasitology* 139 (2006) 371-384.

Waller, P. J. *Veterinary Parasitology* 139 (2006) 1-14.

Krecek, R. C. and Waller, P. J. *Veterinary Parasitology* 139 (2006) 270-282.

Wyk, J. A. van. et al. *Veterinary Parasitology* 139 (2006) 336-346.

Nematode parasite control -Modelling

Work has started on the modelling of parasitic disease, as advocated above.

A computer model to simulate control of parasitic gastro-enteritis in sheep on UK farms has been developed.

This simulates the population dynamics and epidemiology of three major species of parasitic nematodes of sheep found in the UK (*Teladorsagia* [*Ostertagia*] spp., *Haemonchus* spp. and *Trichostrongylus* spp.). The model has been developed as a tool for veterinarians and advisors to aid in the implementation of integrated parasite control strategies designed to optimise anthelmintic usage and delay the development of resistance on UK farms. The model represents the parasite life cycle, flock dynamics and the response of individuals with different susceptible and resistant genotypes to the major broad-spectrum classes of anthelmintic available in the UK. The model allows worm control simulations on individual UK farms. Inputs include environmental and farm management variables which impact on the epidemiology of the disease, e.g. regional weather data; flock stocking rates; initial pasture larval contamination levels and species proportions; lambing dates; timing of flock movements to clean pastures; and removal of lambs during the year. Initial validation of the model outputs has been carried out. Statistical analysis of results shows a positive correlation for observed and simulated counts and regression analysis suggests an acceptable fit between the data. Comparison of observed and simulated outputs for resistance were possible for only one farm due to low numbers of worms developing in the laboratory tests. Additional studies will be necessary before resistance data can be reliably compared. Further validation studies are proposed to ensure that the model is robust and applicable across a diverse range of farm types. The model will be used to demonstrate the advantage, in terms of delaying resistance development, of current guidelines for anthelmintic use and management practices for worm control in sheep.

Learmount, J. et al. *Vet Parasitol.* 142 (2006) 312-329.

Mathematical models to assess strategies for the control of *Ostertagia ostertagi* infections on the growth of young cattle were also described. However, in these papers, an economic assessment of alternative worm control strategies was the main aim.

Ward, C. J. *Veterinary Parasitology* 138 (2006) 247-267 and 268-279.

Nematode parasite control – grazing with cattle

Co grazing or sequential grazing with cattle is often advocated as a way of controlling gastro-intestinal parasitism in sheep. An experiment was conducted in the UK over two successive years (2002 and 2003) to investigate the effects of grazing improved pasture by cattle or sheep, either sequentially or mixed, on the faecal egg counts and growth rates of weaned lambs when treated with anthelmintics. Overall, sequential grazing of pastures with cattle then sheep reduced the faecal egg counts in lambs regularly treated with anthelmintics when compared with lambs grazing in mixed systems with cattle and sheep or with sheep only systems. However, the highest growth rates were observed in lambs in the mixed cattle/sheep grazing system throughout.

Marley, C.L. et al. *Vet Parasitology* 142 (2006) 134-141.

However, a paper published by New Zealand workers indicated that affecting numbers of parasites in refugia by co grazing or sequential grazing with cattle may promote anthelmintic resistance in sheep (see later, Lawrence, K.E. et al. *New Zealand Vet Journal* 54 (2006) 283-288.)

The results of a study in New Zealand to determine if not treating 10% of lambs, or if treating when faecal egg counts (FECs) reached a threshold, would result in measurable increases in parasite larval challenge in the autumn and affect performance, was published. A triple combination anthelmintic was used. *Haemonchus contortus* and *Trichostrongylus* larvae were found to be increased on pastures where selective treatment occurred or when a threshold FEC was used. No differences were detected in other species. This was associated with small production losses in the lambs, which may or may not be acceptable to farmers

Leathwick, D.M. et al. *New Zealand Vet Journal* 54 (2006) 305-312.

Nematode parasite control-alternatives forages

The use of plants containing condensed tannins and their effect on parasite burdens has been studied for a number of years. Papers published in 2006 showed varying effects, depending on the forage, the parasite, stage of infection and the host. Some trials were considered successful, but their use on commercial farms is still to be evaluated.

An investigation was conducted to evaluate the effect of the condensed tannin containing forage; *Lespedeza cuneata* (sericea lespedeza, SL) fed as hay, on *Haemonchus contortus* infection in sheep. The results indicate that SL fed as hay may be more useful to remove existing worms than establishing worms. A decrease in FEC observed would have the benefit of reduced pasture contamination.

Lange, K.C. et al., *Vet Parasitol.* 141 (2006) 273-278.

The objective of another study was to examine the effect of dried and ensiled sainfoin (*Onobrychis viciifolia*) on established populations of *Haemonchus contortus* and *Cooperia curticei* in lambs under controlled conditions. For both, hay and silage, an antiparasitic effect could be shown, offering promising perspectives for the use of conserved tanniferous fodder as a complementary control approach against gastro-intestinal nematodes. Heckendorn, F. et al. *Veterinary Parasitology* 142 (2006) 293-300.

However, not all studies were successful.

The aim of one study was to evaluate the anthelmintic activity of *Azadirachta indica* after feeding sheep with the dried leaves. None of the evaluated parameters of the treatment groups were statistically different when compared to the control group, demonstrating that, with the protocol used, *A. indica* has no anthelmintic effect.

Costa, C.T.C. et al. *Veterinary Parasitology*, 137(2006) 306 – 310.

The effects of condensed tannins in the forage species *Dorycnium rectum* and *Medicago sativa* were shown to be variable against *Teladorsagia circumcincta* and *Trichostrongylus colubriformis* and unlikely to be of practical value. The authors conclude that *in vitro* activity is an unreliable indicator of *in vivo* efficacy for condensed tannin forages and extracts.

Waghorn, T. et al. *New Zealand Vet Journal*. 54 (2006) 21-27.

A review of the subject was provided by Hoste, H. et al. *Trends in Parasitology* 22 (2006) 253-261 and Githiori, J.B. et al. *Veterinary Parasitology* 139 (2006), 308-320, who also proposed further areas for research.

The effect of certain forages on maintaining larvae of *Haemonchus contortus* on the pasture was also investigated as lambs grazing certain legumes have been shown to reduce parasite intensities compared to lambs grazing ryegrass swards. Eighteen replicates of white clover, lucerne, red clover and perennial ryegrass were compared. Overall, red clover affected the development of *H. contortus* and all legumes affected larval migration above 50mm compared with ryegrass but survival of larvae was similar on all forages. Further work is needed to determine if these effects of legume forages would reduce the number of parasitic larvae ingested by livestock under field conditions.

Marley, C.L. et al. *Veterinary Parasitology* 138 (2006) 308 – 317.

Nematode parasite control-biological control

The use of the nematode trapping fungi- *Duddingtonia flagrans* has also been studied extensively in the past. Papers detailing its use in different situations continued to be published in 2006. No commercial product is available as yet and all trials involved the daily feeding of the chlamydo spores of the fungus, which is likely to have limitations

Two trials with limited success in the Netherlands were described.

The impact of daily *Duddingtonia flagrans* feeding to lactating ewes during the first 9 weeks with their young lambs on pasture was instigated in 2002 and 2003. The results demonstrated no effect of *D. flagrans* application during the first 5 (2002) or 4 (2003) weeks. Subsequently, fungus application strongly reduced the yield in faecal cultures of the ewes. This was, however, not reflected in the pasture larval counts, but lower worm burdens were observed in tracer lambs of 'treated' plots in 2002 than on those of 'control' plots. In 2003 worm burdens in 'treated' lambs were lower than those of 'control' lambs. However, in all groups, lambs and tracer lambs developed severe haemonchosis.

Eysker, M. et al. *Vet Parasitol.* 141 (2006) 91-100.

The effects of the daily feeding of spores of *Duddingtonia flagrans* in lambs kept under an evasive grazing system were also studied in the Netherlands. All lambs were fed 200 g of concentrates daily throughout the whole period, and treated groups were also fed 500,000 spores of *D. flagrans*/kg bodyweight daily. The faecal cultures demonstrated a high reduction in yield as a result of fungal application. However, no differences between groups were seen in weight gain, faecal egg counts, pasture larval counts, worm counts and tracer worm counts. *H. contortus* was the dominant species.

Eysker, M. et al. *Vet Parasitology* 140 (2006) 312-320.

There was also an interesting paper on its use in sheep that graze mountain pastures in Spain. Two groups of Churra Tensina ewes were allowed to graze for 8 weeks in the autumn on two separate paddocks of infected pasture near their winter sheds in the valley. At lambing, ewes and their twin lambs were turned out into the same paddocks for the following 12 weeks. One group of ewes received a daily dose of *Duddingtonia flagrans* both in autumn and in spring, while the other group was used as a non-treated control. Daily dosing of grazing ewes with the fungus *D. flagrans* had a clear effect on reducing autumn pasture contamination. This had a subsequent effect on the over-wintering larvae population that was confirmed by a 20% lower worm burden of tracer lambs kept in early spring on the paddock previously grazed by fungus treated ewes. In spring, pasture contamination was also significantly reduced in the paddock grazed by fungi-treated ewes and their lambs showed a 61% lower worm burden and a better performance than the control lambs. This showed that fungal spores fed to sheep at critical times with regard to the epidemiology of parasite infection, can have a significant effect on the infective larvae present on pasture, which could further improve lambs performance.

Gomez-Rincon, C. et al. *Vet Parasitology* 141 (2006) 84-90.

Whether this could have an application in some farming systems in UK is unknown.

Alternative chemical parasite control

The control *Haemonchus contortus* infection with the use of copper continues to receive a lot of attention. Its use in the UK in sheep would be limited because of the risk of copper toxicity. One paper detailed its use in goats

The effectiveness of a sustained-release multi-trace element/vitamin ruminal bolus (TEB) containing copper administered to mature does for control of gastrointestinal nematodes (GIN) during summer months and during late gestation was studied. *Haemonchus contortus* was the predominant nematode during these trials. In both experiments, faecal egg counts were reduced within 7 days in TEB-treated compared with untreated does. PCV was similar between treatment groups (Experiment 1) or tended to be lower in the TEB group (Experiment 2). GIN control did not persist more than 28 days. These studies suggest that TEB may be an effective means of GIN control in mature goats, but additional control measures may be necessary. Burke, J.M. and Miller, J.E. Vet Parasitology 141 (2006) 132-137.

Nematode control -nutrition

Protein supplementation is known to improve the resistance to parasites of periparturient ewes, as indicated by reduced nematode egg excretion and worm burdens. In one paper, the effect of nutritional status and fat reserves on the periparturient immune response to *Haemonchus contortus* infection in sheep was studied. The results supported the view that higher levels of nutrition during early pregnancy enhance the expression of immunity against gastrointestinal parasites around parturition. Furthermore, the differences in the immune response appeared associated with serum leptin concentrations suggesting that leptin may be a key link between nutritional status and the protective immune reactivity against GI nematode infection. Valderrabano, J. et al. Vet Parasitology 141 (2006) 122-131.

In a second paper, a rapid improvement of immunity to *Teladorsagia circumcincta* was achieved through a reduction in the demand for protein in lactating ewes. This was thought to be associated with increased parasite expulsion, reduced fecundity and non-parasite specific reduction of *in vivo* larval establishment. Houdijk, J.G. et al. Int J Parasitol. 36(2006) 219-227.

Effects of breed on resistance to gastro-intestinal parasites

Limited information is available on differences between sheep breeds with respect to helminth resistance under temperate conditions. In this paper Suffolk and Texel sheep breeds were compared in Eire. The results showed an influence of breed on resistance to naturally acquired trichostrongyle infection. In trial 1, significantly higher faecal egg count (FEC) and worm burden was observed in Suffolk compared with Texel lambs following natural challenge. In trial 2, FEC recorded in lambs from six farms confirmed the breed differences previously observed. A breed difference in resistance to GI parasites was also observed in older ewes. In both breeds, an age effect on the FEC was observed with younger ewes having greater FEC than older ewes.

It concluded that Texel sheep are more resistant to natural nematode challenge than Suffolk sheep based on faecal egg count and nematode burden

Good, B. et al. Veterinary Parasitology 136 (2006) 317 – 327.

Nematode parasite control-eradication

An alternative view to maintaining parasites in refugia is that of attempting eradication. This should only be attempted where there is a good chance of success, as it could lead to a rapid development of anthelmintic resistance.

One paper described its use against *Haemonchus contortus* in Sweden. Previous studies had shown that between-year transmission of *Haemonchus contortus* in Swedish sheep flocks is almost entirely as over-wintered populations within housed animals, and not on pasture. This suggested that eradication of this parasite is a realistic possibility. Thus, two sheep farms with a history of *H. contortus* infection on a Swedish island were selected for study. During the winter housing period of 2003/2004 all ruminants (sheep and cattle) on both farms were treated with ivermectin. Monitoring by faecal egg counts and infective larval differentials of ewes and lambs for the subsequent two grazing seasons, together with total abomasal worm counts of 10 lambs from each farm at the end of the first grazing year, showed that this objective was achieved.

Waller, P.J. et al. *Veterinary Parasitology* 136 (2006) 367-372.

Diagnosis of parasitic disease by molecular methods

A review of molecular tools and their possible use in the accurate identification of parasites, the diagnosis of infection and analysis of genetic variation was published. The first two applications would be very applicable to the work of the VLA. The use of a two step, semi-nested PCR based assay was reviewed where diagnosis of *Habronema* infection of horses by examination of faeces samples was shown to be similar to autopsy, but superior to the traditional coprological examination. A PCR assay has also been developed for the detection of *Oesophagostomum bifurcum* directly from human faeces (without prior egg concentration), which demonstrates the feasibility of developing methods for the diagnosis of strongylid nematode infections in livestock. The prospect of developing real-time PCR based assays for the quantification or semi-quantification of parasite DNA in the faeces of infected hosts would also appear possible in the future

Gasser, R.B. Proceedings of the third annual meeting of the European Veterinary Parasitology College (EVPC), Vilnius, Lithuania, 27 May 2005. *Veterinary Parasitology* 136 (2006) 69-89.

The validation of PCR based methods was reviewed in a paper by Conraths and Schares. The high level of analytical sensitivity can make these techniques susceptible to cross contamination and carry-over problems leading to false positives. Also the presence of inhibitors may cause false negative results. After initial validation a test should be continuously monitored.

Conraths F.J. and Schares, G. *Veterinary Parasitology* 136 (2006) 91-98.

A multiplex PCR assay for differentiating strongyle eggs from cattle has been described in 2001; however, the egg disruption and DNA extraction procedures, though effective, were inadequate for large studies or clinical application. The purpose of one study was to evaluate methods for disrupting trichostrongyle eggs, then assess commercial kits for extracting egg DNA using *Ostertagia ostertagi* as a model species. Results showed that egg disruption was best accomplished with the bead beater and ceramic beads, resulting in 100% disruption within 1 min. When DNA extraction was preceded by the isolation of eggs from faeces (by sugar flotation), all procedures except the Fast DNA kit produced PCR-ready DNA from at least two eggs. The DNeasy Plant kit was the most sensitive, allowed consistent detection of DNA released from one egg. Acceptable results were also obtained with Fast DNA kit, which utilises fewer steps with a detection limit of 11 *Ostertagia ostertagi* eggs. Due to the morphological similarities among trichostrongyle eggs in ruminants, strongyle eggs in equids, and hookworm eggs, the methods described here may have broad application to other nematodes. Harmona, A.F., Zarlengac, D.S. and Hildreth, M.B. Veterinary Parasitology 135 (2006) 297-302.

Anthelmintic Resistance in Sheep

The results of a small scale survey of ivermectin resistance in sheep nematodes using the faecal egg count reduction test was published.

Thirty-eight sheep flocks, predominantly from the south/central Scotland, were examined using a faecal egg count reduction test (FECRT) for the presence of ivermectin (IVM) resistant nematodes. Efficacies of less than 95%, 14–17 days post-treatment, were identified in 6 of 17 naturally grazing flocks where pre-treatment faecal egg counts were in excess of 150 eggs per gram. Efficacies on these IVM resistant farms ranged from 66 to 92%. The larvae detected in post-treatment coprocultures from resistant flocks were from the genera *Teladorsagia* (4 from 6) and *Trichostrongylus* (2 from 6). Bartley, D.J. et al. Veterinary parasitology 137 (2006) 112-118.

A prevalence study of anthelmintic resistance on New Zealand sheep farms found, by using faecal egg count reduction tests, resistance to ivermectin was most commonly detected.

- ivermectin resistance was detected on 36% of farms,
- resistance to ivermectin and levamisole on 10%, of farms,
- resistance to ivermectin and albendazole on 13% of farms and
- resistance to ivermectin and levamisole and albendazole on 8% of farms.

Resistance to albendazole was seen in all parasite genera, resistance to levamisole in *Nematodirus* spp, *Ostertagia* spp and *Trichostrongylus* spp. Resistance to ivermectin was dominated by *Ostertagia* spp. No resistance was detected on 36% of farms

Waghorn, T.S. et al. New Zealand vet Journal 54 (2006) 271-277.

An attempt was made, by a cross-sectional study and a logistic regression model to identify management practices that are associated with macrocyclic

lactone (ML) resistance on sheep farms in New Zealand. The odds of ML resistance increased on farms

- that had used a long acting ML in ewes as a pre-lambing treatment for 3 or 3+years out of the last 5
- where less than 70% of stock mid winter were sheep (reducing sources of parasites in refugia)
- which purchased greater than 10% of number of sheep present mid winter
- where fine wool breeds were present

Lawrence, K.E. et al. New Zealand Vet Journal 54 (2006) 283-288.

Similar studies in the temperate areas of Australia where resistance to macrocyclic lactone (ML) anthelmintics was identified (with <95% reduction of FEC to a half dose of ivermectin) associated resistance in *Ostertagia* spp to use of moxidectin for ≥ 2 of the five previous years.

Rendell, D.K. et al. New Zealand Vet Journal 54 (2006) 313-317.

The implications for development of anthelmintic resistance by treatment of adult ewes were the subject of another New Zealand paper. Over a three year period, anthelmintic resistance to albendazole increased most rapidly in both *Ostertagia* and *Trichostrongylus* spp where the ewes had been given a controlled release albendazole capsule (not available in UK) pre lambing. There was also an increase where the ewes were given a single dose of albendazole 2-3 weeks post lambing compared to a system where ewes were left untreated and lambs received a regular 6 doses of albendazole post weaning. The effect of leaving the heaviest 15% of lambs untreated on the development of anthelmintic resistance was not conclusive, but the trend was for the slowest development of resistance.

Leathwick, D. M. et al. New Zealand Vet Journal 54 (2006) 297-304.

Resistance in naturally acquired *T. circumcincta* infection on a sheep farm in New Zealand to a combination anthelmintic containing ivermectin-levamisole-albendazole was reported. This was the first confirmed report of resistance to a combination drench containing 3 different classes of anthelmintics in this country. The authors conclude that this is evidence of the continuing escalation of multiple anthelmintic resistance in sheep nematodes in New Zealand.

Wrigley, J. et al. New Zealand Vet Journal 54 (2006) 47-49.

The results of the work in New Zealand has led one author to conclude that anthelmintic resistance in sheep has increased to disturbingly high levels, but the majority of affected farmers do not appreciate their problem, because most do not test for it. Sheep farmers should avoid 'high risk' practices such as treating adults where there is no need, dose and move to 'clean' pasture and failing to quarantine treat bought in stock. In light of the above findings, they should also endeavour to avoid treating ewes pre-lambing with long acting anthelmintics.

Pomroy, W.E. New Zealand Vet Journal 54 (2006) 265-270.

Anthelmintic Resistance in Cattle

The prevalence of anthelmintic resistance in beef herds in North Island of New Zealand was estimated in a study published in 2006. Faecal egg count reduction tests (FECRT) were used and resistance confirmed if there was a <95% reduction in samples taken 7-10 days later. Resistance to ivermectin was predominant. The results were

Farms with no resistance –7%

Farms with ivermectin resistance-92%

Farms with albendazole resistance-74%

Farms with levamisole resistance-6%.

Cooperia spp was the most prevalent resistant species (resistant to both ivermectin and albendazole) *Ostertagia* spp resistant to ivermectin was evident on 9% of farms, to albendazole on 35% farms and to levamisole on 9%

Intensive beef producers as well as mother and calf enterprises were studied but differences between the two could not be extracted in this study, but it was thought to be small

Waghorn, T.S. et al. New Zealand Vet Journal 54 (2006) 278-282.

To gain information on farming practices and test for associations between the presence of anthelmintic resistance and farming practices, a questionnaire was devised and sent to New Zealand beef cattle rearing farms. MLs were used most frequently. No association of ML resistance with management practices could be determined.

Jackson, R. et al. New Zealand Vet Journal 54 (2006) 289-296.

These results from New Zealand have led one author to conclude that all cattle farmers there should be using combination anthelmintics on most occasions to achieve effective control of all parasites.

Pomroy, W.E. New Zealand Vet Journal 54 (2006) 265-270.

Detection of anthelmintic resistance

Coles et al produced a review of the methods of detection of anthelmintic resistance in nematodes of veterinary importance. This was produced as a basis for discussion, prior to recommendations being made by WAAVP. Suggestions as to the use of FECRT with persistent anthelmintics and continuous release devices were given. It was commented that further development of PCR is needed before it can be used to detect anthelmintic resistance in the field. Except for dose and slaughter trials, there are no validated tests for detection of resistance to flukicides or anti-cestode drugs. Coles, G.C. et al. Veterinary Parasitology 136 (2006) 167-185.

In vitro methods

Benzimidazole (BZ) resistance in *Haemonchus contortus* is linked primarily with the mutation in the beta-tubulin isotype 1 gene that substitutes

phenylalanine (Phe) to tyrosine (Tyr) at 200 codon of the gene. In one study, a new restriction fragment length polymorphism-polymerase chain reaction (RFLP-PCR) technique has been developed for detection of BZ resistance in the beta-tubulin isotype 1 gene of *H. contortus*. The results indicated that RFLP-PCR is an easy, reproducible and less expensive method than allele specific PCR. The authors conclude that this technique will be helpful in establishing the prevalence rate of BZ resistance in *H. contortus*.
Tiwari, J. et al. *Veterinary Parasitology* 138 (2006) 301-307.

G. von Samson-himmelstjerna wrote a review of molecular methods for diagnosis of anthelmintic resistance in 2006. Molecular markers that correlate well with benzimidazole resistance have been detected for a number of years. Recently, a single nucleotide polymorphism was found *in vitro* to have relevance in ML resistance. These raise the possibility of useful tests being developed in the future.
von Samson-himmelstjerna, G. *Veterinary Parasitology* 136 (2006) 99-107.

A modified larval migration assay for detection of macrocyclic lactone resistance only in *Haemonchus contortus* was described. The test was ineffective with *Teladorsagia circumcincta* and *Trichostrongylus colubriformis*, therefore reducing its use in field situations to where *H. contortus* was predominant.
Kotze, A.C. et al. *Veterinary Parasitology* 137 (2006) 294-305.

In vivo methods

The repeatability of the faecal egg count reduction test was investigated in a New Zealand publication. Where fully resistant or fully susceptible populations were present it represented a useful test but there was considerable variation in the outcomes of FECRTs and therefore they urged caution where efficacy of treatment fell in the 90-95% range. The possibility of false negative results was also acknowledged.
Miller, C.M. et al. *New Zealand Vet Journal* 54 (2006) 323-328.

In two further papers no difference was detected in using simple ways of calculating FECRT (i.e. where no treatment, control groups where used) compared to more complex calculations.
McKenna, P.B. *New Zealand Vet Journal* 54 (2006) 202-203 and 365-366.

Parasite vaccines

W.D. Smith and Zarlenga D.S reviewed the developments and hurdles present in generating vaccines for helminths of grazing ruminants.
Vet Parasitology 139 (2006) 347-359.

Cattle Parasites

General

A study into moxidectin (a long acting, injectable formulation) use in cattle was published. *Cooperia* spp comprised the majority of post treatment strongyle eggs detected. At a dose rate of 1mg/kg bw, post treatment protection periods were 90 days for adult *Haemonchus* spp, 120 days for *D. viviparous*, adult *Ostertagia* spp and *Oesophagostomum* spp and 150 days for early fourth stage larvae of *Ostertagia* spp.

Yazwinski, T.A. et al. *Vet Parasitology* 137 (2006) 273-285.

The use of bulk milk ELISA tests for quantitative estimates of parasite infection was the subject of a paper to BCVA in 2006. *Ostertagia ostertagi*, and *Fasciola hepatica* already have tests available. *Dictyocaulus viviparous* and *Chorioptes bovis* are possible future parasite candidates.

Forbes, A.B. and Charlier, J, *Cattle Practice* 14 (2006) 167-173.

Grazing management for worm control in cattle

To evaluate non-chemical strategies to control pasture-borne parasites in first-season grazing (FSG) cattle, a 3-year grazing trial was conducted during 2002-2004 on naturally infected pastures on a commercial beef cattle farm in Sweden. A uniform pasture was divided in 4 equal paddocks onto each of which 10, 5-9 months old dairy breed steer calves were allocated at turnout in May each year. Two strategies were evaluated: (1) turnout onto pasture which had been grazed the previous year by second-season grazing (SSG) steers, followed by a move to aftermath in mid-July (RT) and (2) supplementation with concentrate and roughage for 4 weeks from turn-out (FD). Comparisons were made with an untreated (UT), and an anthelmintic treated control group (DO). In conclusion, the rotation control strategy showed promising results, whereas the strategic feeding was poor from a parasite control standpoint.

Larsson, A. et al. *Vet Parasitol.* 142 (2006) 197-206.

Dictyocaulus viviparous

Anthelmintic resistance in lungworm in cattle has received little attention. However in 2006 workers in Brazil described ML resistance in a *Dictyocaulus viviparous* population that they were studying.

Molento, M.B. et al. *Vet Parasitology* 141 (2006) 373-376.

COCCIDIOSIS

Coccidiosis in Poultry

Control

A paper “The influence of immunizing dose size and schedule on immunity to subsequent challenge with antigenically distinct strains of *Eimeria maxima*” (Blake et al, Avian Pathology 34 (2006) 489-494) reported on the problems associated with immunization poultry with *Eimeria maxima*. This species of *Eimeria* is very effective at producing an immune response following vaccination and subsequent challenge with a homologous strain, but not a heterologous strain. This paper confirms that genomic research may suggest there is a pool of antigens, which can give, cross-protection.

Another paper by the same authors (Blake et al, International Journal for Parasitology 36 (2006), 97-105) reported on “The influence of host genotype on parasite reproduction as revealed by quantitative real-time PCR”. This is an important subject for work with live coccidial vaccines because these may need modifications for different strains of chickens.

Most current thinking regarding control of coccidiosis in poultry considers that vaccination will be the usual method in the future, with anticoccidial drugs being unsuitable because of resistance problems. Three papers reported that the use of live, attenuated coccidial vaccines on poultry farms, which previously had resistance to anticoccidials, resulted in an increase in sensitivity to the drugs after as few as 2 cycles of vaccination. “Increased level of *Eimeria* sensitivity to Diclazuril after using a live coccidial vaccine”, (Mathis & Broussard. Avian Diseases 50 (2006), 321-326); “Higher incidence of *Eimeria* spp. field isolates sensitive for Diclazuril and Monensin associated with the use of live coccidiosis vaccination with Paracox-5 in broiler farms”, (Peek & Landman. Avian Diseases 50 (2006) 434-439); and “Revitalisation of anticoccidial activity in poultry flocks by the use of a live attenuated vaccine”, (Ralph Marshall. Buletinul USAMV-CN, 63/2006, p464).

A very comprehensive review Article on the control of coccidiosis was published in the Czech Republic. “Progress in control measures for chicken coccidiosis”, Kitandu & Juranova, Acta. Vet. Brno 75 (2006) 265-276.

Two papers on dietary control were published:

Dalloul et al, (Poultry Science 85 (2006) 446-451) reported on the use of extracts from mushrooms to boost cell-mediated immunity and coccidiosis in poultry. Early results indicate that the use of these extracts appeared to offer some protection against *E. tenella* infections. (“Immunopotentiating effect of a Fomitella fraxinea-derived lectin on chicken immunity and resistance to coccidiosis”).

A paper by a Chinese team reported on the control of coccidiosis using different oils in the diet. It was found that saturated fatty acids aggravated coccidiosis caused by *E. tenella*. (“Fatty acids and coccidiosis: effects of

dietary supplementation with different oils on coccidiosis in chickens". Yang et al, *Avian Pathology* 35 (2006) 373-378).

Concurrent infections

A paper from Iran reported on the relationships between coccidiosis, cryptosporidiosis and aflatoxins. ("Occurance of natural intestinal and bursal cryptosporidiosis and coccidiosis in broiler chickens in experimental aflatoxicosis", Gharagozlou et al, *Indian Journal of Animal Sciences* 75, (2006) 653-654).

Bulgarian researchers confirmed the relationship between coccidiosis and necrotic enteritis, as reported in last year's VPG summary. ("Effect of *Eimeria acervulina* on experimentally induced necrotic enteritis in broiler chickens", Lyutskanov et al, *Bull Vet Inst Pulawy* 50 (2006) 153-158).

Technical

A review paper by Morris & Gasser (2006) provided a background on coccidiosis and outlined the traditional and molecular techniques used for diagnosis. ("Biotechnological advances in the diagnosis of avian coccidiosis and the analysis of genetic variation in *Eimeria*". *Biotechnology Advances* 24 (2006) 590-603).

A paper from USA described a method for extracting oocysts from poultry litter and determining which species of *Eimeria* was present using PCR. Although of interest to researchers this would have little on-farm application unless a cost-effective portable system could be developed. Jenkins *et al*, *Avian Diseases* 50 (2006) 110-114.

Coccidiosis in Alpacas

An interesting paper described a case of coccidiosis in Alpacas in Peru "*Eimeria macusaniensis* and *Eimeria ivitaensis* co-infection in fatal cases of diarrhoea in young alpacas (*Lama pacos*) in Peru". Palacios et al, *The Veterinary Record* 158 (2006) 344-345.

Coccidiosis in Wildlife

A conservation project sponsored by the Zoological Society of London and the Royal Society for the Protection of Birds used VLA's expertise to identify parasites in a captive breeding flock of ciril buntings. ("Atoxoplasmosis associated with morbidity and mortality in captive and translocated ciril buntings (*Emberiza cirilus*)". *Proceedings of VII European Wildlife Disease Association Congress, Aosta, Italy. 27-30 September 2006*).

Coccidiosis In Cattle

A discussion of control of bovine coccidiosis was produced in 2006. Complete eradication of coccidia is not possible due to their ubiquitous nature and high degree of resistance in the environment. Calf areas remain contaminated for extended periods. Disinfectants have not been found to be very effective unless they remain in direct contact with oocysts for some hours. Lessening the temperature to 15°C and ensuring maximum humidity of 80% will significantly reduce the occurrence of clinical coccidiosis on some farms. Maddox-Hyttel, C. In: 24th World Buiatrics Congress, Nice 2006
Bayer satellite symposium on bovine coccidiosis

Two studies were described carried out on farms with a history of bovine coccidiosis. Their aim was to investigate the epidemiology of coccidiosis in calves and its control with toltrazuril (15mg/kg LWt) and diclazuril (1mg/kg LWt) and to determine suitable times for administering metaphylactic treatment. They showed that control with toltrazuril (BAYCOX 5%) was achieved with one dose whereas diclazuril (VECOXAN) required repeated doses. The authors conclude that toltrazuril provides more persistent control and is suitable for protecting both calves which are already infected but whose infection is still pre-patent and those which do not become infected until later. Mundt, H-C. et al. In: 24th World Buiatrics Congress, Nice 2006
Bayer satellite symposium on bovine coccidiosis

An experiment reported on concurrent coccidial and helminthological infections. They concluded that coccidial infection with *Eimeria alabamensis* was more important than infections with nematodes, or concurrent infections with both parasites on the performance of calves on pasture. Larsson et al, Parasitology Research 99 (2006), 84-89.

Two different disinfection methods (flame gun and liquid ammonia spray) were selected, and their efficacy against the coccidian oocysts of sheep and goat was studied. The difference between the two methods was highly significant, the 10% ammonia spray being more effective as a disinfection method, based on reduction in mean oocyst count. Kumar P. et al. Indian Veterinary journal 83 (a) (2006) 1017-1018