



VLA PARASITOLOGY GROUP
ANNUAL HORIZON SCANNING REPORT

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Executive summary

This is a summary of a horizon scanning report of 184 peer and non-peer reviewed papers in parasitology published in 2007, of relevance to the VLA and Defra.

This report addresses and supports many of the key aims of the Animal Health and Welfare Strategy including

- *Our disease status is amongst the highest in the world and we are able to trade our animals and animal products internationally.*
- *Consumers 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 sheep.

This report also supports the aim of better dissemination of research to veterinarians, to produce high quality practical advice to livestock keepers.

This fourth 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 are summarised below:

1. Protection of public health

Cryptosporidia spp.

- Subclinical infections in lambs, orphan lambs at petting farms, a goat from a petting farm and a pet dog with the potential for zoonotic transfer were all described in papers this year.
- Zoonotic transmission of *C. parvum* from alpaca crias to humans was also reported.

Echinococcus multilocularis

- Alveolar echinococcosis caused by *Echinococcus multilocularis* is an important lethal zoonotic helminth infection in the northern hemisphere. Currently, the threat to public health is increasing, as evidenced by the rising prevalence rate of alveolar echinococcosis, as well as the invasion of urban areas by infected wild foxes.

- Although *E. multilocularis* is currently not present in the UK , its introduction remains a threat as it appears to be expanding its geographical range in Europe.

Echinococcus granulosus

- This zoonotic parasite is present in the UK, with evidence that incidence is increasing in known hot spots.
- Further papers were published that showed improved tests for demonstrating infection in the definitive host (dogs) and some intermediate hosts (sheep).

Trichinella sp.

- From 1999 – 2007 over 3500 wild foxes have been tested in GB and all have been negative for trichinae showing a statistical prevalence of 0.001% in GB foxes. One fox was found positive for *T. spiralis* in Northern Ireland in 2007, which may have consequences for the level of testing of pigs in the future. There have been no reports of trichinae in domesticated pigs in the UK since 1979.
- In Europe the fox and wild boar are the main hosts of infection, with increases being seen in wild boar infection in Poland. In the USA a resurgence of the disease has been related to eating of game meats.

Tick borne diseases

- *Anaplasma phagocytophilum* may cause infection in several animal species and humans (where it causes human granulocytic ehrlichiosis) and is transmitted by ticks.
- It has been identified as one of the emerging zoonoses in European countries.
- A paper examining ticks and tick-borne pathogens of companion animals in the Netherlands detected *Babesia microti* and *B. venatorum* (known to be pathogenic in humans) in *Ixodes ricinus* ticks as well as several exotic tick species.

2. Disease prevention and control for sustainable development

Parasitic diseases are a major cause of disease and therefore production loss particularly in farmed ruminants. Resistance to chemical methods of control threatens sustainable development.

Fasciola hepatica

- A paper published in 2007 indicated that *Fasciola hepatica* infection may interfere with the *Mycobacterium bovis* (TB) skin diagnostic test in cattle, by the known immunomodulatory affects of fluke infection, but further work was required.

- Research is active into mechanisms of action of various flukicide drugs and furthering understanding of flukicide resistance.

Gastro-intestinal parasites

- There was increased detection of anthelmintic resistance in gastro-intestinal parasites of cattle as well as sheep
- Improvement in the understanding and detection of anthelmintic resistance continues, particularly with the use of molecular studies
- Papers continue to be published into alternative, non-chemical methods of control of gastro-intestinal parasitism in the face of growing anthelmintic resistance

Ectoparasites

- Development of resistance in ectoparasites and ticks has led to searches for alternative methods of control, similar to research into helminthiasis.

3. Protection and promotion of the welfare of animals

Parasitism of animals can affect their welfare by causing weight loss, diarrhoea, increased risk of fly strike and pruritis.

- The hopes of an effective vaccine in the future against *Fasciola hepatica* were raised by publication of work by Polish workers.
- An successful experiment to substitute anthelmintic resistant parasites on a farm, with anthelmintic susceptible ones was published
- Work on the use of coccidial vaccines in poultry houses has shown that it is possible to replace parasites showing anticoccidial resistance with sensitive ones.

4. Protection of the wider economy, environment and society

- A paper explored the potential for improving welfare standards and productivity in United Kingdom sheep flocks was published in 2007. Improvements in control of major infectious disease by the use of compulsory veterinary flock health plans was advocated. It was estimated that costs would be no more than the current average yearly spend on veterinary fees and medicines by sheep farmers
- An eminent researcher has also concluded that, in order to conserve the drugs that are available for control of ectoparasites in sheep, there is a need to develop more fully integrated programmes.

Both these papers support animal health planning and promotion of best practice as outlined in the animal health and welfare strategy

5. International Animal Health

- In the UK, the Health Protection Agency aims to collate and enhance existing data on the distribution of all ticks found in Britain. At this time, this scheme does not test ticks for any pathogens they may carry.

INTRODUCTION.

This is a summary of peer and non-peer reviewed parasitology literature published in 2007. 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 and Defra.

CRYPTOSPORIDIOSIS

General papers

There were very many papers presented at the 2nd International *Giardia* and *Cryptosporidium* Conference in Morelia, Mexico in May 2007. Probably the most relevant was the plenary paper by Ronald Fayer from the USDA titled "Advances in *Cryptosporidium* Research". He reported that there are now more species of *Cryptosporidium* identified in animals and humans than formerly assumed, with the advances in molecular techniques responsible for a greater understanding of the organism.

Jackie Marshall from VLA Weybridge reported on a "Survey for the incidence of *Cryptosporidium* spp. oocysts from pet samples submitted to the laboratory" which found an overall infection rate of 8% in both dogs and cats. Other papers looked at control, survival in the environment, and detection techniques.

Proceedings of the II International *Giardia* and *Cryptosporidium* Conference, Morelia, Mexico, May 2007.

A proposal was made in 2006 to re-name *C. parvum* (bovine genotype) as *C. pestis* and to restrict the name *C. parvum* to the "mouse genotype". The author refutes this proposal, suggesting that the new species name should be considered invalid.

Xiao, L. et al. Trends in Parasitology 23 (2007) 41-43

Waterborne *Cryptosporidium* has been responsible for drinking water-associated disease outbreaks in a number of developed countries. As a result of the resistance of *Cryptosporidium* to chlorine, current management practices are focused on source-water management and water treatment as ways of preventing *Cryptosporidium* from entering drinking-water supplies. In the event that treatment barriers fail, a more thorough understanding of the fate of oocysts in water distribution systems, with emphasis on *Cryptosporidium*-biofilm interactions, is required.

Angles, M. L. et al. Trends in Parasitology 23 (2007) 352-356

A review chapter with several references to *Cryptosporidium*---the organism, detection methods, water treatment and their association with molluscan shellfish was published in 2007.

Graczyk, T K and Fried, B. Advances in Parasitology 64 (2007) 112-150

Cryptosporidial infection in cattle

A paper discussed the prevalence of *Cryptosporidium* species and genotypes in mature dairy cattle on farms in eastern United States compared with younger cattle from the same locations,

C. parvum, *C. bovis* and *C. andersoni* were found on 2, 6 and 8 farms respectively and infected 0.4%, 1.7% and 3.7% of the 541 cows examined on 14 farms. The overall lower prevalence of *Cryptosporidium* in these cows was highly significant compared with younger cattle. The very low level of infection with *C. parvum* suggests that mature dairy cattle are a relatively low risk source of infection for humans

Fayer, R. et al *Veterinary Parasitology* 145, (2007) 260-266

C. parvum oocysts were detected in the faeces of 78% of the 919 calves from which four faeces samples had been collected on a weekly basis, the majority were diarrhoeic at the time of sample collection. Factors associated with an increased risk of diarrhoea were leaving the calf with the dam for more than one hour after birth, and the birth of a calf in the summer rather than the winter. Calves shedding *C. parvum* oocysts had 5.3 times the odds of diarrhoea than non-shedding calves. Infected calves shedding more than 2.2×10^5 oocysts per gram faeces were more likely to have diarrhoea than infected calves shedding lower numbers of oocysts.

Trotz-Williams, L. A. et al. *Preventive Veterinary Medicine* 82 (2007) 12-28

This work in Greece concluded that *Cryptosporidium* spp. plays an important role in the diarrhoeic syndrome of calves. The highest % of oocysts was found in calves aged <14 days.

Panousis, N. et al. *Cattle Practice* 15 (2007) 89-92

The authors in one paper question the perception that *C. parvum* is a major cause of diarrhoea and production loss in cattle and believe that cattle have been unfairly implicated in outbreaks of cryptosporidiosis in humans.

O'Handley, R. M. *Trends in Parasitology* 23 (2007) 477-480

Previous work in the United States has shown that ~85% pre-weaned dairy calves were infected with zoonotic *C. parvum*. Only 1-2% of post-weaned calves and 1-2 year old heifers were infected with this species. *C. bovis* and *C. deer-like* genotype were much more prevalent in post-weaned animals. This work examined the *Cryptosporidium* infection pattern in China and India, together with Georgia, USA. In all 3 areas *C. bovis* was the most common species in pre- and post- weaned calves and the authors concluded that *C. bovis* and the deer-like genotype are found in all age groups of cattle in diverse geographic areas.

Feng, Y. et al *Veterinary Parasitology* 144 (2007) 1-9

Cryptosporidial infection in sheep

The results of this study into *Cryptosporidium parvum* infection in orphan lambs on a farm open to the public show that it can be a significant zoonotic

hazard. Oocysts were detected in the faeces of lambs up to 12 weeks old, with peak counts between 4-6 weeks. The oocysts were confirmed as *C. parvum*. Virtually all infections were sub-clinical.

Pritchard, G C. et al. *Veterinary Record* 161 (2007) 11-14

Cryptosporidial infection in pigs

Infections were detected in 39 out of 342 animals, with the highest rates among weaners (15%) and sows (13%). Infections with *C. parvum* were rare. Other species identified included *C. suis*, *C. pig* genotype 2, *C. muris* and a previously unidentified genotype. Chronic mixed infections appear quite common in pigs but are generally apathogenic.

Zintl, A. et al. *Parasitology* 134 (2007) 1575-1582

Cryptosporidial infection in alpacas

An outbreak of cryptosporidiosis among alpaca crias and their human caregivers. The findings of this investigation suggested that the zoonotic transmission of *C. parvum* from alpacas to humans can occur.

Starkey, S. R. et al. *JAVMA* 231 (2007) 1562-1567

***In-vitro* studies**

Colleagues from VLA and HPA reported on "Detection and identification of *Cryptosporidium* species in companion animals" and compared different methods employed to detect oocysts. For routine testing it was found that FAT and IMS-FAT were sufficient for most applications, with IMS improving detection by up to 600%. PCR was then needed to positively identify the species.

Proceedings of the II International *Giardia* and *Cryptosporidium* Conference, Morelia, Mexico, May 2007.

Jackie Marshall from VLA Weybridge presented a paper at both Mexico and the WAAVP conference in Gent comparing the sensitivities of the mZN and FAT staining methods for the detection of *Cryptosporidium* oocysts on slides. It was reported that the FAT was more sensitive, and was able to detect oocysts up to 4 days earlier in experimentally infected animals.

Proceedings of the II International *Giardia* and *Cryptosporidium* Conference, Morelia, Mexico, May 2007, and Proceedings of WAAVP 21st International Conference, Gent, Belgium, August 2007.

A rapid method for producing highly purified *Cryptosporidium parvum* oocysts. The isolation method described in this paper, using faeces from infected calves, is based on differential flotation of *C. parvum* oocysts in NaCl, followed by ether extraction to solubilize lipids in calf faeces. The procedure regularly yields >10⁹ purified *C. parvum* oocysts within 1-2 days of faeces collection.

O'Brien, C N and Jenkins, M C. *The Journal of Parasitology*, 93 (2007) 434-436.

Gastric species of *Cryptosporidium*, *C. muris* and *C. andersoni*, excyst in both acid and neutral conditions at 37°C. Intestinal species, *C. parvum* and *C. hominis* did not respond to acid. This indicates that *Cryptosporidium* oocysts have evolved to maximize delivery of sporozoites to the region of the gut where the parasite multiplies.

Widmer, G. et al *Parasitology* 134 (2007) 583-1588,

Zoonosis

The application of molecular epidemiological tools has helped to resolve taxonomic issues, allowing cycles of transmission to be determined. In addition, advances have been made in elucidating mechanisms associated with pathogenesis, whereas only limited progress has been achieved in the areas of chemotherapy and prophylaxis.

Thompson, Andrew R C, et al, *The Veterinary Journal* (In press. Electronic version available <http://dx.doi.org/doi:10.1016/j.tvjl.2007.09.022>)

An investigation explored sub-clinical infection in lambs submitted to VLA regional laboratories for general disease diagnosis. *C. parvum* was confirmed in 43 of 266 lambs. Clinical cryptosporidiosis was diagnosed in 13 of these lambs. Peak prevalence of oocyst shedding was at 3-4 weeks.

Pritchard, G. et al. VLA Conference Poster Glasgow International Zoonoses conference 2007

Cryptosporidium has a life-cycle suited to waterborne and foodborne transmission. There are 16 "valid" *Cryptosporidium* species and a further 33+ genotypes described. Genetic exchange is frequent in *C. parvum* populations, leading to the generation of a very large number of different genotypes. In contrast, genetic exchange appears rare in *C. hominis* resulting in much lower resolution between isolates. Sub-genotyping tools offer increased discrimination, specificity and sensitivity of isolates, which can be exploited for investigating the epidemiology of disease.

Smith, H V et al. *Veterinary Parasitology* 149 (2007) 29-40

A girl, her brother and their dog in Peru were all diagnosed with *Cryptosporidium canis* infections during the same period. Both children had transient diarrhoea but the dog was asymptomatic. This is the first report of possible transmission of cryptosporidiosis between humans and dogs.

Xiao, Lihua, et al. *Journal of Clinical Microbiology*, June (2007) 2014-2016

Reports of naturally-occurring *C. hominis* infections in animals are few. Until 2005 they were limited to non-farmed animals. During epidemiological studies into possible animal sources of human sporadic cryptosporidiosis cases in south-west England, one pygmy goat was identified shedding moderate levels of *Cryptosporidium* oocysts. The species was shown to be *C. hominis*. The goat was from a petting farm. A child had been diagnosed with *C. hominis* having visited the petting farm 2 weeks previously.

C. hominis was also identified in the caecal contents of a 10 day old Texel lamb investigated as part of an unrelated survey to examine the prevalence of *Cryptosporidium* in lambs.

The likelihood of transmission to man from animal sources needs to be further evaluated. This is the first evidence of *C. hominis* in sheep in the UK and the first evidence of *C. hominis* in goats worldwide.

Giles, Michaela, et al. *Cryptosporidium hominis* in a goat and sheep in the UK (Veterinary Record In press),

TRICHINELLOSIS

The XII International Conference on Trichinellosis, took place in Croatia, in September 2007. All aspects of this disease were covered.

Immunology

Microwave irradiation of trichinae *Trichinella spiralis* was used to immunize mice against challenge infection. Such a method might be a promising a prophylaxis vaccine against trichinellosis in animals and/or humans. The possibility of using microwave irradiation to decontaminate meat was also proposed.

Ali, Safia M. et al. Journal of the Egyptian Society of Parasitology 37 (2007) 121-133

The effect of concurrent infections with other helminths in pigs was investigated to see if there was any synergistic or antagonistic interaction with *Trichinella spiralis*. *T. spiralis* muscular larval burdens were increased in pigs concomitantly infected with *Metastrongylus apri*, they were reduced in pigs concomitantly infected with *Ascaris suum*, compared to pigs receiving single infections with either of these helminths.

Frontera, E. et al. Veterinary Parasitology 146 (2007) 50-57

More work was done looking at the immune protective response at the mucosal level in SPF pigs showing that *Trichinella (T spiralis)* infection gave a dominant Type 2 profile in the mucosa.

Picherot, M. et al Veterinary Parasitology 143 (2007) 122-130

Surveys

The prevalence of trichinosis in GB foxes was reported and a new digestion method for fox muscle was described. From 1999 – 2007 over 3500 wild foxes have been tested and all have been negative for trichinae showing a statistical prevalence of 0.001% in GB foxes. There have been no reports of trichinae in domesticated pigs since 1979. Zimmer, I.A et al Veterinary parasitology 151 (2008)233-241

One fox was found positive for *T. spiralis* in Northern Ireland in 2007.

Zimmer, I.A et al. In, XII International Conference on Trichinellosis, Croatia, 2007.

Trichinella prevalence was studied in red foxes and wild boars in Poland, The average prevalence rate of *Trichinella* spp. infection of foxes was 4.4%. Large differences of the infection rate in wild boars were observed. In the years 1999-2001 *Trichinella* spp. larvae were observed in 58 animals (0.2%) and

between 2002 and 2004 the *Trichinella* spp. prevalence in 227 wild boars was 0.9%, demonstrating that the animals were 5.1 times more often infected than in 1999-200. The growth of red fox population after the oral vaccination against rabies was probably the cause of this phenomenon.

Balicka-Ramisz, A. et al Deutsche Tierärztliche Wochenschrift 114 (2007) 354-357

Also wild carnivores in Slovakia, Lithuania, Latvia and Estonia were studied. There were four *Trichinella* species in Europe: *T. spiralis*, *T. britovi*, *T. nativa* and *T. pseudospiralis*. In most European countries, the principal host during the parasite's sylvatic cycle was the fox. In one study in Slovakia, the highest prevalence of *Trichinella britovi* was established among red foxes (19.7 %) and martens (37.5 %). The parasite was also detected in European polecat and brown bear. No infection was detected in wolves, badgers, otters, weasels, and stoats.

Hurnikova, Z. et al. Helminthologia 44 (2007) 18-20

Meat of domestic pigs and wild boars has been the significant source of emerged human trichinellosis in Lithuania, Latvia, and Estonia over the past two decades. However, there is very little known on the occurrence of *Trichinella* spp. in main wildlife reservoirs and its transmission in domestic and sylvatic cycles in these countries. The present study demonstrated considerably higher endemicity of *Trichinella* spp. in main sylvatic reservoirs (28.9-42% in foxes (*Vulpes vulpes*) and raccoon dogs (*Nyctereutes procyonoides*) in all three countries than previously reported. Molecular identification of *Trichinella* larvae from more than 500 sylvatic and domestic animals revealed four *Trichinella* species (*Trichinella spiralis*, *Trichinella britovi*, *Trichinella nativa*, and *Trichinella pseudospiralis*). The study suggests that transmission of *Trichinella* between domestic and sylvatic cycles in Lithuania and Latvia is favoured by improper human behaviour, e.g., pig and slaughter waste management.

Malakauskas, A. et al. Parasitology Research 100 (2007) 687-693

In 1995, a new species of *Trichinella* (*Trichinella zimbabwensis*) was discovered in farmed Nile crocodiles (*Crocodylus niloticus*) in Zimbabwe, where the mode of transmission was their consumption of the meat of slaughtered crocodiles, which was used as feed. The ability of this species to infect poikilotherm vertebrates (i.e. monitor lizards and Nile crocodile) in Zimbabwe, Mozambique and Ethiopia was studied. *T. zimbabwensis* was found in these wild reptiles, and the findings are consistent with reports that vertebrates with scavenger and cannibalistic behaviour are the most important hosts of *Trichinella* spp. The wide distribution of monitor lizards and crocodiles in Africa and the development of national crocodile breeding programs in many African countries should be taken into consideration when evaluating the risk of transmission of this parasite to mammals, including humans.

Pozio, E. et al Veterinary Parasitology 143 (2007) 305-310

The epidemiology of Trichinellosis in China was studied. All *Trichinella* isolates from domestic pigs were identified as *T spiralis*. Some *Trichinella* isolates from dogs in north eastern China were identified as *T nativa*, which

has muscle larvae that are highly resistant to freezing. Twenty-seven outbreaks of human trichinellosis associated with mutton, dog and game meat occurred in China between 1964 and 2004, but the quarantine of *Trichinella* larvae in such meat is not mandatory in China at present.

Wang, ZQ et al *Veterinary Journal* 173 (2007) 391-398

T. spiralis was identified as one of 15 emerging zoonotic diseases in Europe. The authors advised that uniform case definitions should be introduced throughout Europe as true prevalence and incidence estimates are otherwise impossible.

Vorou, RM. et al. *Epidemiology and Infection* 135 (2007) 1231-1247.

Meat of wild boars is the main source of infection for humans in Poland, horses infected with *T. spiralis* have also been a significant source of human trichinellosis in Europe. Feeding of animal products to horses in order to condition them prior to sale creates a major risk of *Trichinella* infection. Horse meat from Poland is therefore considered a major risk for human infection because of the high level of environmental contamination with *Trichinella* infected meat in the country.

Gawor, J. *Zycie Weterynaryjne* 82 (2007) 611-614

Detection

Work in Croatia has shown that the trichinella ELISA is not suitable for testing at slaughter due to the occurrence of false negatives. The currently prescribed method of trichinelloscopy (which can prevent the infection of people, but it is definitely insufficient to prevent the spread of trichinellosis) will be replaced with digestion tests.

Baric, J. et al *Meso* 9 (2007) 96-103

Giemsa stain was used to make rapid detection possible in compressed diaphragm samples without magnification procedures. The trichinae and nurse cells showed up blue against the pink background of the muscle fibres.

Ramirez-Melgar, C. et al *Korean Journal of Parasitology* 45 (2007) 65-68

An incomplete artificial digestion method for the production of testing proficiency (QA) samples was described in France. Use of the samples had resulted in increased performance by the testing laboratories after five sessions. This method cannot be used in GB however as it involves live trichinae.

Vallee, I et al. *Journal Of Food Protection* 70 (2007) 1685-1690

The non-encapsulated species *Trichinella pseudospiralis* has been detected in mammals and birds, and human infection has occurred, in some cases resulting in death. Genetic methods of detection of *T. pseudospiralis* showed it to be polymorphic, having three distinct genotypes corresponding to the three regions of origin

Wu, Z. et al. *Parasitology Research* 101(2007) 1567-1573.

The new European food hygiene legislation was criticised as being very complex and confusing with many fundamental shortcomings that would cause problems with international food trade and safety for member states. Riedil, R. and Riedl, C. Deutsche Lebensmittel-Rundschau 103 (2007) 457-479

Immunochromatographic strip methodology has been developed to give rapid serological diagnosis of human and animal trichinella (*T spiralis*) infections. Qin YinXia et al. Chinese Journal of Zoonoses 23 (2007)866-868

Disease Reports

Cases of trichinellosis in humans were reported from many countries including Europe and USA. Smoked sausage and frozen wild boar meat were blamed. In the USA a resurgence of the disease has been related to eating of game meats. In Poland disease was associated with eating 'backyard pigs' and wild boar.

Cvitkovic, Ante et al Acta Med Croatica 61 (2007) 215-8.

Gaillard, T et al Annales De Biologie Clinique 65 (2007) 308-312

Golab, E et al. Euro Surveill 12 (7):E070719.2 2007

Madariaga, M G et al American Journal Of Tropical Medicine And Hygiene 77 (2007) 347-349

Reiterova, K. et al. Infection 35 (2007):89-93

Sadkowska-Todys, M; Golab, E. Przegl Epidemiol 61 (2007)301-4

Disease Risks

In Italy the main hosts for *Trichinella* sp. are the fox and wild pig. Risks of human disease were also thought to be associated with imports from Eastern European countries and wild boar from Sardinia.

Domenichini, A. Rivista di Suinicoltura 48 (2007) 40-43

Trichinella infection from hunted and farmed game meats was reviewed. The authors concluded that there was an increased risk of *Trichinella* sp from hunted game.

Gill, CO Meat Science 77(2007) 149-160

Infectivity of trichinae

The horse is considered an aberrant host for the nematode parasite *Trichinella spiralis*, and many aspects of the biology and epidemiology of Trichinella infection in the horse are poorly understood. Viability and infectivity of *T. spiralis* trichinae, a non freeze tolerant species, in frozen horse meat was assessed and showed small numbers could survive at least 4 weeks at -18°C. Hill, DE et al Veterinary Parasitology 146 (2007)102-106

Larval viability and serological response was examined in horses infected with *T. spiralis*. Trichinae lasted for the whole year of the study but serological response fell off after 26 weeks. This showed that parasite recovery

techniques, digestion methods, are the only suitable detection methods for the inspection of horse meat.

Hill, DE *Veterinary Parasitology* 146 (2007) 107-116

Disease Review

World distribution of *Trichinella* species was reviewed and showed that the only place it had not been found was Antarctica.

Pozio, E *Veterinary Parasitology* 149(2007)3-21

Treatment of disease in humans

It is common for patients with trichinellosis to show worsening symptoms when treated with anthelmintic drugs alone. An additional short course of prednisone was shown to be safe and to alleviate symptoms due to tissue larvae.

Shimoni, Z et al *Israel Medical Association Journal* 9 (2007) 537-539

The effect of under dosing with anthelmintics (albendazole or mebendazole) was studied in mice and showed that future generations of these *Trichinella* had the potential for anthelmintic resistance.

De-La-Rosa, JL et al *Tropical Biomedicine* 24(2007) 93-97

CESTODES

Echinococcus granulosus

Control

Knowledge of the longevity of the different stages of parasites in the environment is important in formulating control programs. A study was carried out in Turkey, which examined the longest survival time of *Echinococcus granulosus* protoscolices stored at different humidities (RH) and constant temperatures from -10 to +40°C. It was concluded that, under natural conditions in Turkey, the larval stages of *E. granulosus* survive 3 to 36 days during the cold winter season (-10 to 0°C), 12 to 28 days during spring (10 to 20°C) and 3 to 4 days in hot summer periods (30 to 40°C) in discarded sheep carcasses. Considering their epidemiological importance in the disease, it was advised that stray and roving dogs should be properly controlled and preventive control programs established to prevent access to infective larval stages.

Diker, A.I. et al *Veterinary Parasitology* 150 (2007) 84-87.

Surveillance in dogs

The development of sensitive and specific ante-mortem diagnostic methods for the detection of canine echinococcosis is important for epidemiological baseline data and for surveillance of hydatid control programmes.

Detection of parasite antigens in faeces has become an important alternative laboratory-based method for diagnosis of intestinal infections caused by helminths. A study carried out in Tunisia assessed the performance of two laboratory diagnostic methods compared with arecoline purgation and necropsy in infected dogs. The results indicated that arecoline purgation was highly specific but had a sensitivity of only 64% for pre-patent *E. granulosus* infection in experimental dogs. A coproELISA was reliable for detecting pre-patent infections in dogs with high sensitivity (82.8%). A coproPCR method was able to detect 25.9% of *E. granulosus* infected dogs pre-patently and produced no false positive reactions. The authors suggested that surveillance of canine echinococcosis for epidemiological studies or hydatid control programmes can be achieved more effectively by the application of coproantigen ELISA and specific confirmation of copropositives by coproPCR than by arecoline purgation.

Lahmar, S. et al *Veterinary Parasitology* 144 (2007) 287–292.

Parts of Western Sichuan Province, China, that is occupied by Tibetans, has one of the highest prevalence rates of human hydatid disease yet recorded. In recent years an immunological test for *Echinococcus* spp. antigens in dog faeces has been developed (coproantigen ELISA). The antigens appear to be carbohydrates, which survive proteolytic digestion and environmental degradation. This paper describes a modification of the test whereby capture and detection antibodies are generated exclusively to the carbohydrate portion of the parasite tegument.

The use of this modification as a surveillance tool in an extensive field trial of hydatid control in Western Sichuan is described. From 2003 onwards all dogs received a treatment with praziquantel in the spring and the autumn of each year. The percentage of coproantigen-positive samples decreased progressively during the control period from 2000 to 2005 from 50 to 17%. The modified test is robust, sensitive and safe and cost-effective for large-scale epidemiological surveillance and is now being used as part of the Chinese National Hydatid Disease Control Program.

Huang, Y et al. *Veterinary Parasitology* 149 (2007) 229–238

Surveillance in sheep

Immunodiagnosis of hydatid disease in sheep presents problems of sensitivity and specificity, limiting its applicability in surveillance systems. This study in Argentina was to develop a sensitive, specific and accessible technique for diagnosing cystic echinococcosis in naturally infected sheep and to evaluate the validity of necropsy as a reference test.

A total of 247 sheep were studied at slaughterhouses, confirming the parasitological diagnosis with histology. Serum was processed with enzyme immunoassay (EIA) using three antigen preparations: total hydatid liquid (LHT), purified fraction of LHT (S2B) and purified lipoprotein (B). Western Blot (WB) was used as a control. EIA proved effective for differentiating *Echinococcus granulosus* from larval stage of *Taenia hydatigena* and intestinal cestodes in all three antigen preparations.

Macroscopic diagnosis at the time of slaughter was found to have limitations as a reference test for immunodiagnosis of cystic echinococcosis in sheep, so

it was necessary to include histology and WB as reference tests. LHT was the antigen preparation of greatest value and EIA proved to be a sensitive and specific technique, adequate for surveillance systems and for evaluating control programmes.

The results indicated much higher sensitivity and specificity compared with previously published reports of attempts at developing an immunodiagnostic test for ovine echinococcosis.

Gatti, A. et al *Veterinary Parasitology* 143 (2007) 112–121

Echinococcus multilocularis

Alveolar echinococcosis caused by *Echinococcus multilocularis* is an important lethal zoonotic helminth infection in the northern hemisphere. Currently, the threat to public health is increasing, as evidenced by the rising prevalence rate of alveolar echinococcosis, as well as the invasion of urban areas by infected wild foxes. This threat is further increased due to the involvement of pet dogs, and probably cats, as emerging sources of infection. These increased threats to public health also have associated economic risks and therefore there is a need for effective and sustainable methods of control. In this paper, initiatives to control alveolar echinococcosis by targeting its definitive hosts through anthelmintic baiting campaigns initiated by local residents who used local resources for bait production, distribution and collection of fecal samples for diagnosis are described. When such distribution programs are coupled with the use of GIS-based maps, the optimum distribution of bait was obtained. Overall, the results of this study in Japan showed that the use of collaborative control initiatives targeting zoonotic agents can be an effective method for reducing the threat of alveolar echinococcosis in the northern hemisphere.

Kamiya, M. *Journal of Veterinary Science* 8 (2007) 313-321

Echinococcus multilocularis appears to be expanding its geographical range in Europe. This study reports on the emergence of the parasite in the European westernmost edge of its geographical distribution, based on two consecutive parasitological examinations of red foxes (*Vulpes vulpes*) sampled between 1996 and 2003 in The Netherlands. The average worm count increased from 2.6 worms per fox in the first surveillance study to 16.6 worms per fox in the second. Using a mathematical model for a spatially spreading parasite, a strong indication that the parasite population is increasing in number and is spreading northward at the speed of 2.7km per year was described. They analysed a parasite control strategy by estimating the critical fox density for parasite elimination and conclude that *E. multilocularis* is an emerging parasite in The Netherlands and thus in the western part of Europe and that control will be very difficult given the current high fox population density.

Takumi et al (2007) *Int J Parasitol.* In Press, Epub ahead of print 12 Oct 2007

A study was published to assess and describe the current spectrum of emerging zoonoses between 2000 and 2006 in European countries. A computerized search of the Medline database from January 1966 to August 2006 for all zoonotic agents in European countries was performed using

specific criteria for emergence. Fifteen pathogens were identified as emerging in Europe from 2000 to August 2006 including *Echinococcus multilocularis*. Multi-disciplinary preventive strategies addressing these pathogens are of public health importance. Uniform harmonized case definitions were advised to be introduced throughout Europe, as true prevalence and incidence estimates are otherwise impossible.

Vorou, R. M. et al. *Epidemiology and Infection* 135 (2007) 1231-1247.

Taenia species

In spite of the EU directives that regulate meat inspection for bovine cysticercosis, *Taenia saginata* is still present in Europe and causes economic losses due to condemnation, refrigeration and downgrading of infected carcasses. Taeniosis is not a notifiable disease; therefore the incidence of taeniosis is usually estimated from the sale of taenocidal drugs. In Europe prevalence rates between 0.01% and 10% have been reported. The authors refer to a recent study in Belgium that identified the flooding of pastures, free access of cattle to surface water and the proximity of wastewater effluent as significant explanatory variables for bovine cysticercosis to be recorded in a herd. Demographic pressure has also been suggested to be a risk factor i.e. higher population density can increase the risk of bovine cysticercosis. The main reasons for the persistence of bovine cysticercosis include the low sensitivity of current meat inspection protocols, the dissemination and survival of eggs in the environment and cattle husbandry systems, which allow grazing on pastures and drinking from water streams. It is assumed that water streams and surface water are potentially contaminated with *T. saginata* eggs. The authors discuss an integrated approach for control as well as the potential use of serological methods as a way of improving detection of bovine cysticercosis.

Dorny, P and Praet, N. *Veterinary Parasitology* 149 (2007) 22–24

Taenia solium causes human neurocysticercosis, a public health problem in many developing countries, particularly Latin America. Tapeworm carriers are very rarely found and in necropsy studies practically no tapeworms have been reported. The lower prevalence of taeniosis in necropsies versus their presence in living carriers could be explained by digestion of the tapeworm after death of the host. In this paper the authors analyze the possibility that, after the death of the host, tapeworms could easily be destroyed in the intestine. Experiments, performed in the hamster model suggest that the absence of tapeworms in the human intestine during necropsy is not due to post-mortem digestion. An alternative explanation for this inconsistency is that *T. solium* has a short lifespan.

Garza-Rodriguez, A. et al *Veterinary Parasitology* 145 (2007) 172–175

ECTOPARASITES

Cattle ectoparasites

Unlike the situation in the UK, warble fly is still a problem to cattle in other European countries. A study was undertaken in north western Spain to

compare three methods of warble fly detection. In Spain the most prevalent species is *Hypoderma lineatum* and so serological tests were directed at this species. The three methods were: detection of L1 instars in oesophageal tissue at post mortem; the indirect ELISA for antibody detection and sandwich ELISA for antigen (HyC) detection. An indirect ELISA was used in the GB eradication campaign, but the authors were keen to look at the use of an antigen detection ELISA as this would be more specific for current infestations. There is persistence of antibody after larvae have been removed from the host. It was conceded that early and reliable diagnostic techniques are necessary for preventing economic losses. It was reported that, unlike antibodies, HyC remained low in early infestation with two peaks relating to migration of the larvae. The paper concluded that the episodic increases in circulating HyC would limit the usefulness of the sandwich ELISA for the early diagnosis of hypodermosis.

Panadero R. et al *Veterinary Parasitology* 147 (2007) 297-302.

A longitudinal survey was conducted from July to November 2000 involving 2 abattoirs and 287 oesophagi to look for *H. lineatum* larvae and give an estimate of prevalence and seasonality. The study concluded that overall prevalence was 19% with maximum percentage positive in October. This dropped to the lowest figures in November suggesting migration of the larvae from the oesophagus to the back at this time. Although random sampling of 10% of the abattoir throughput was undertaken there was no attempt to produce slaughter figures for the target population or sample size calculations to indicate how the study figures could be reliably related to the cattle population of Mexico. However, results produced coincided with the seasonality data from other North American sites.

Quintero-Martinez, M.T. et al *Veterinary Parasitology* 146 (2007) 189-191.

The cattle tick *R. microplus* is responsible for considerable losses in cattle production due to transmission of tick borne diseases. There is a search for potential alternative control strategies in response to the development of resistance to commercial acaricides. Plant extracts provide a novel and safe alternative to traditional preparations. Plant products such as the oleoresin from Copaiba trees have been used to treat a wide range of conditions and has shown insecticidal properties against immature *Culex quinquefasciatus*. This resin was mixed with distilled water and DMSO and used against larvae of *R. microphilus in vitro*. Results revealed the product as a potential botanical acaricide producing 99% larval mortality at relatively low concentrations. The authors suggest that further research may indicate even greater success with fractions of the oleoresin.

From a conservation point of view the medicinal properties could be a potentially auto sustainable resource of acaricide - further supporting preservation of the Amazonian forest.

Fernandes F.F. and Freitas E.P.S. *Veterinary Parasitology* 147 (2007) 150-154.

Improved methods of tick detection to improve decision making for treatment are required to allow more accurate tick monitoring and treatment and so

decrease the development of resistance to acaricides. With this in mind, the authors investigated the use of near infrared reflectance spectroscopy (NIRS), which has successfully been used in nutritional monitoring of grazing livestock. Previous research has shown that this technique has been able to differentiate between male, pregnant and lactating sheep; ovariectomized, early and late gestation cattle and been able to differentiate sex and species of deer. The objective of the study was to determine the ability of the technique to discriminate between pre and post tick infested cattle and horses. The technique is based on differentiating between “end products” in faeces related to the fact that infestation should provide a stressful environment- ticks are known to modulate the immune system of the host. If the spectral signatures related to levels of parasitism can be established then producers would have a non invasive method to identify carrier animals. In conclusion, differences were noted but there was insufficient evidence to determine the actual cause of fecal spectral differences. Therefore further research would be required. Like many alternative control methods, there appears to be some benefit but whether the benefits are economically justifiable if used alone is doubtful.

Tolleson D.R. et al. *Veterinary Parasitology* 147 (2007) 150-154.

Amitraz is a worldwide popular acaricide which, compared to other therapies, is relatively cheap with minimal toxicity. In Australia it is the only effective acaricide available for application to dairy cattle by spray or dip. Because of this it is important to preserve amitraz as an effective acaricide. In Australia resistance developed within five years of its introduction but despite this it is still effective. Estimates of the prevalence of resistance have been undertaken with 10% reported for a study of Queensland dairy properties. This is low in comparison with resistance to synthetic pyrethroids where figures of 56% are quoted. Results from various reviewed studies support the hypothesis that amitraz resistance has not increased dramatically in recent years and that resistance has emerged slowly. Few risk factors for resistance have been confirmed, but it seems likely that resistance is related to frequency of treatments. A study of farms with resistance also provided evidence that cattle movement is a reason for dissemination of resistance. Studies using genetic analysis are to be undertaken in an attempt to confirm the hypothesis, which if true would support biosecurity as a method to reduce importing resistant stock onto a farm. Another factor was the tendency for resistance to wane when selection pressure i.e. treatment was not applied. Studies suggested an incomplete dominant mode of inheritance. The mechanism of resistance is unknown but diagnosis is possible using a larval packet test bioassay with further molecular tests under development.

Jonsson N.N. and Hope M. *Veterinary Parasitology* 146 (2007) 193-198.

A review aimed to discuss the underlying principles, emerging issues relating to ectoparasites and to highlight novel approaches, which may be incorporated, into future control programmes was published. The author discussed the varying roles of ectoparasites and how they vary greatly with time spent on the host often inversely proportional to pathogenicity. This makes obvious sense with ectoparasites which are almost commensals having a less pathogenic effect on their hosts while more mobile parasites are

much less dependent on the survival of the host. Besides the co-evolved relationship between parasite and host, there has been a relatively recent influence of husbandry practices, which will have altered the balance of certain relationships. The author states that some problems have been exacerbated by artificial selection of livestock for certain characteristics. For example, the selection of sheep for thicker wool has resulted in modern sheep breeds more susceptible to a range of ectoparasites. There are two basic methods of ectoparasite control – eradication and management. The former may be desirable but is not always practical, sustainable or economically viable. When dealing with ectoparasite infestation the author states that, with consideration of the difficulty of removal and the increase in resistance, a rational approach to intervention needs to be developed. In certain infestations there may be a critical threshold for the instigation of control methods, while with other species infestation requires immediate intervention and that the concept of a threshold below which they can be safely ignored cannot be applied. The launch of new products is rare and unlikely and in order to conserve the drugs that are available there is a need to develop more fully integrated programmes with parasiticides just one component. Management and husbandry practices need to be addressed. Novel research tools including molecular techniques for diagnosis, simulation modeling and satellite imagery will provide a better understanding of the epidemiology of infestations. As for novel methods of control – biological control, off- host trapping systems and the identification and the possibility of the selective treatment of susceptible animals were discussed, areas of interest to the Bristol research group.

Wall, R. *Veterinary Parasitology* 147 (2007) 150-154.

VECTOR BORNE PARASITIC DISEASES

VLA Surveillance reports

February 07 – *I. ricinus* ticks were associated with scratching/pruritis in more than 50 sheep from a group of 500 by VLA Aberystwyth, no lice or mites were detected in wool samples taken

April 07 – VLA Newcastle diagnosed Babesiosis, post mortem, in a 5 year old Limousin cross cow associated with an infestation of ticks.

May 07 – Louping Ill was diagnosed in sheep by both VLA Penrith (1 case) and Aberystwyth (2 cases) where deaths of 8 sheep from a flock of 800 and 11 from a flock of 50 respectively were reported.

June 07 – Louping Ill was diagnosed in sheep at both VLA Penrith and Starcross.

August 07 – VLA Starcross diagnosed Babesiosis in a 4year old South Devon Cow. *I. ricinus* ticks were found and a history of clinical babesiosis in the herd at this time of year for at least four previous years was noted. *Babesia* parasites were detected in meningeal intravascular erythrocytes

September 07 – VLA Shrewsbury diagnosed babesiosis in a suckler cow from Anglesey; two other cows on the same farm had recently died showing respiratory signs. Several cases on other farms on the island had been reported by veterinary surgeons. Langford and Penrith both reported cases of babesiosis from farms with no previous history of the disease. Penrith also reported cases of Louping ill in sheep.

October 07 – Louping ill was diagnosed post mortem by VLA Penrith in a 12 year old suckler cow. On the same farm, sheep had been vaccinated with LIV vaccine until 2001 after which time vaccination was discontinued. The farmer reported the loss of some 30 ewes during 2007, the majority down to Louping ill. VLA Winchester reported the diagnosis of tick borne fever (*Anaplasma phagocytophilum*) in a two year old bull, which had lost condition after being introduced to a herd of cows. Eperythrozoonosis (*Mycoplasma wenyonii* infection) was also reported in cattle during October from both Sutton Bonnington and Langford. Clinical signs included udder oedema, swollen hocks and mild pyrexia. *M. wenyonii* is most commonly transmitted by biting flies but has also been associated with transmission by *I. ricinus*.

November 07 – VLA Langford diagnosed Louping ill in a cow, which had exhibited neurological signs. IgM antibody was predominant, indicating a recent infection.

It is interesting to note that in the majority of Louping ill cases diagnosed during the year, farmers had reported recent use of cypermethrin or deltamethrin as a preventative insecticide / acaricide treatment of their animals.

International Consortium on Ticks and Tick-borne Diseases (ICTTD)

The ICTTD-3 is a Co-ordinated Action supported by INCO, the International Cooperation program of the European Union. The aim of the ICTTD is to support a research program on tick-borne diseases jointly executed by a consortium of 43 institutions in 29 different countries.

A newsletter is published three times a year and contains the latest information on publications concerning ticks and tick-borne diseases.

Electronic copies are freely available online and can be found in the archive section of their website: <http://www.iccttd.nl>

ICTTD newsletter 33, June `07 carries 13 reviews of papers describing recent work on potential candidate molecules for vaccination against ticks and tick-borne disease pathogens. Work described includes gene expression, tick proteins, genetics of resistance, salivary proteins with anti-complementary activity. Papers describing molecular genetic methods of taxonomy of tick borne eukaryotes and protists also figure highly.

UK tick recording scheme

In collaboration with the Biological Records Centre (www.brc.ac.uk), the Health Protection Agency aims to collate and enhance existing data on the distribution of all British ticks (available on the National Biodiversity Network gateway (www.searchnbn.net), in order to fill the gaps in our current

understanding of tick distributions and to encourage the sharing of up-to-date distribution data. At this time, the tick recording scheme does not test ticks for any pathogens they may carry. Information about Lyme disease and tick awareness is available on the Health Protection Agency's [Lyme borreliosis webpage](#)

Individuals and groups are invited to assist in the development of the NBN (National Biodiversity Network) database (www.searchnbn.net) on tick distributions by sending in any ticks collected, along with details of:

- date of collection
- specific location (grid reference)
- general location (nearest town/village)
- local habitat (e.g. woodland, pasture)
- host from which tick was collected (e.g. human, dog)
- contact details of the individual sending in the sample
- If more than one tick is collected from different hosts or different locations they should be placed in separate labelled containers.
- If more than one tick is collected from the same host or habitat on the same day, they may be sent in one container.

All specimens sent in will be identified, and thus provide regular updates for the NBN gateway. This will update and enhance knowledge of tick distributions in the British Isles, and improve understanding of public and veterinary health risks posed by ticks and tick-borne infections.

Review of publications

A report published in 2007 describes case of a dog suffering from a co-infection with *Babesia* and *Anaplasma* parasites. *Anaplasma platys* (ex Ehrlichia platys) was found to be responsible for the anaplasmosis by molecular techniques, while microscopical and serological evidence was used to diagnose a coexistent babesiosis, although this could not be confirmed by polymerase chain reaction. The paper highlights the risk of importation of exotic pathogens in companion animals.

Heyman, P et al. Journal of Veterinary Medicine Series A – Physiology, Pathology, Clinical Medicine 54 (2007) 276-279

A paper published described how the authors examined almost 4,300 ticks collected by veterinary practitioners in the Netherlands between 2005 – 2006, most from dogs and cats. Ticks were identified and examined by molecular methods for tick-borne pathogens. Some of the more interesting results included: A male *Hyalomma (marginatum) rufipes* found on a horse. (*H. rufipes* is an African species and was assumed to have been brought in on a migratory wild bird). *Rhipicephalus turanicus* found on a dog that had visited France (*R. turanicus* is not a native French Rhipicephalus species!). *Babesia*

microti and *B. venatorum*, known to be pathogenic in humans were detected in *Ixodes ricinus* ticks.

This looks to be an excellent response from the Dutch vets and in the light of potential climate change it would seem high time that similar surveillance was carried out on both resident companion animals and those entering UK.
Bodaan, C et al. Tijdschrift fur Diergeneeskunde 132(2007) 517-523

Animal skin separates the inner world of the body from the largely hostile outside world and is actively involved in the defence against microbes. A number of viruses, bacteria and parasites use arthropod vectors to deliver them into the dermis while taking their blood meal. Within the dermis, successful pathogens subvert the function of a variety of skin cells or cells of the innate immune system that migrate to the site of infection. In this review several interactions between relevant vector-borne pathogens and cells of the skin are discussed, highlighting the different ways these pathogens have developed to survive within the skin and to usurp the defence mechanisms of the host for their own ends.

Frischknecht, F. Cellular Microbiology 9 (2007) 1630-1640

Iris is a specific elastase inhibitor expressed in the salivary glands of *Ixodes ricinus*. It belongs to the superfamily of serpins and interferes with both haemostasis and the immune response of the host. This study shows that Iris is expressed in nymphs but not in the female midgut nor in males and is present in the saliva. To examine its potency as anti-tick vaccine candidate, three models of *I. ricinus* infestation were set up on immunized animals: nymphs on mice, adults and nymphs on rabbits. A rise of neutralizing antibodies following immunization of rabbits and mice with Iris was demonstrated with a significant protective immunity against *I. ricinus* on rabbits only. This resulted in a 30% mortality rate, diminution of weight gain in both nymphs and adults and a prolongation of blood feeding time in adults. This is the first report of a potential *I. ricinus* vaccine trial using a protein able to interact with both host immunity and haemostasis, as a vaccinating antigen.
Prevot, PP et al. Vaccine 25 (2007) 3284-3292

As obligate blood-feeders, one possible strategy to reduce disease transmission by ticks is to disrupt their ability to digest host proteins. However, the constituent peptidases secreted in tick gut and their potential interplay in the digestion of the blood meal are poorly understood. A novel asparaginyl endopeptidase (legumain) is described and characterized from *Ixodes ricinus* (termed IrAE), which is believed to be the first such characterisation of a clan CD family Cl 3 cysteine peptidase (protease) in arthropods. Using molecular methods, IrAE was shown to cleave the major protein of hemoglobin, to a predominant peptide of 4 kDa. Also, IrAE trans-processed and activated the zymogen form of *Schistosoma mansoni* cathepsin B1 - an enzyme contributing to haemoglobin digestion in the gut of *Schistosoma spp.* The possible functions of IrAE in the digestive processes of *I. ricinus* are compared with those suggested for other hematophagous parasites.
Sojka, D et al. International Journal for Parasitology 37 (2007) 713-724

Anaplasma phagocytophilum may cause infection in several animal species including humans. The disease in domestic ruminants is called tick-borne fever (TBF), and has been known for at least 200 years. In Europe, clinical manifestations due to *A. phagocytophilum* have been recorded in sheep, goat, cattle, horse, dog, cat, roe deer, reindeer and human. However, several other mammalian species have been seropositive and PCR-positive. The infection is transmitted by *I. ricinus* and is prevalent in most countries in Europe. *A. phagocytophilum* infection may cause high fever and severe neutropenia and is characterized by cytoplasmic inclusions in phagocytes, but is seldom fatal unless complicated by other infections. Complications may include abortions, and impaired spermatogenesis for several months. However, the most important aspect of the infection at least in sheep is its implication as a predisposing factor for other infections. Factors such as climate, management, other infections, individual conditions etc. are important for the outcome of the infection. *A. phagocytophilum* may cause persistent infection in several species. Based on the 16S rRNA gene sequences several variants exist. Different variants may exist within the same herd and even simultaneously in the same animal. Variants may behave differently and interact in the mammalian host.

This review also highlights the recent interest in *A. phagocytophilum* as a human pathogen.

Stuen, S. Veterinary Research Communications 31(2007) 79-84 Suppl. 1

Clinical and laboratory manifestations as well as pregnancy outcomes of 6 women diagnosed with *A. phagocytophilum* infection (human granulocytic ehrlichiosis) during pregnancy are described. Human granulocytic ehrlichiosis did not seem to present in a fulminant fashion, and patients had excellent responses when treated with rifampin or doxycycline. Perinatal transmission was documented in 1 neonate, who responded well to treatment. There do not appear to be any long-term adverse sequelae in children born to mothers infected with *A. phagocytophilum* (mean follow-up duration, 21 months).

Dhand, A et al. Clinical Infectious Diseases 45 (2007) 589-593

The diagnosis of equine granulocytic ehrlichiosis was determined in a one year old mare and in two 18-year old mares by examination of giemsa stained blood smears and detection of morulae in neutrophils. The horses were also positive by FAT and by nested PCR for *A. phagocytophilum*. *Ixodes ricinus* was found on all three horses. Symptoms included depression (3/3), partial loss of appetite (3/3), oedema on the lower chest (1 /3), fever (1 /3), icterus (2/3), pale mucous membranes (1 /3), tachycardia (1/3), abnormal lung sounds (2/3), petechia, ecchymoses (2/3), and coffee coloured urine (1/3). Complications appeared in the young mare including acute renal failure, pneumonia and laminitis. Oxytetracycline was used as an antibiotic of choice with a dosage of 7 mg/kg b.w. bid intravenously until the thrombocytes were in normal range. Seroepidemiologic surveys of horses in endemic areas have shown between 26 and 33% prevalence.

Schusser, G. et al. Pferdeheilkunde 23 (2007) 351

Although *Ixodes ricinus* ticks are mainly associated with woodland, they are also present in open habitat such as pastures. The distribution of *I. ricinus*

nymphs was monitored by blanket drag sampling vegetation in May-June 2003 on 61 grazed permanent cattle pastures in central France. Tick abundance was modeled on the perimeter of the pasture using a negative binomial model that took into account data overdispersion. The presence of trees providing shade around the pasture perimeter, the presence of trees or bushes at the pasture edge, woodland around the pasture and a high number of *I. ricinus* nymphs in the nearest woodland to the pasture were also favorable to the abundance of *I. ricinus* nymphs captured in the pasture. The study highlighted that woodland vegetation associated with humidity and the presence of attractive foraging areas for tick hosts around the pasture played a key role in the abundance of *I. ricinus*. Finally, the results raised the question of whether and how transfer of ticks between woodland and grazed pastures occurs.

Boyard, C et al. Parasitology 134(2007) 987-994

Doxycycline generally alleviates clinical monocytic ehrlichiosis, but its efficacy in the control of monocytotropic ehrlichial pathogens requires further investigation. In this study, *Ehrlichia canis* was detected in dogs treated with doxycycline for 14 days and in ticks fed on these dogs, suggesting that treated dogs can remain reservoirs for *E. canis*.

Schaefer, JJ et al Antimicrobial Agents and Chemotherapy 51 (2007) 3394-3396

Lyme borreliosis is a tick borne disease in the UK and abroad. In the UK, *Ixodes ricinus* is the important vector with *I. scapularis* important in the USA. With global warming it is likely that such diseases will become more prevalent and potentially more important in the UK. This paper was based on the interaction between *I. scapularis* and *B. burgdorferi*, but the findings can be extrapolated to other tick species. The spirochete has developed mechanisms to survive within both the tick vector and its mammalian host, which includes the preferential expression of certain genes. It has been shown that the spirochete protein OspA has an important role in retention of the organism in the tick gut with a designated tick receptor TROSPA identified. Infected nymphs expressed this receptor more abundantly than uninfected controls. It would be advantageous for the spirochete to induce the tick to produce high levels of TROSPA to enable the spirochete to persist in the gut in the intervals between blood meals. Salp 15, a tick gene inhibits activation of T lymphocytes and is enhanced by the spirochete. Infection of naïve mice with *B. burgdorferi* and recombinant Salp 15 resulted in higher spirochete numbers compared with *Borrelia* infection alone.

The authors stated that an understanding of the interactions between vector and pathogen would help in the development of control strategies. For example a TROSPA vaccine could lead to decrease spirochete colonisation and survival in the tick gut leading to diminished transmission to a host. A vaccine to Salp 15 could also diminish or indeed inhibit the transmission to the host of the spirochete pathogen. Future studies, they advised, should focus on the identification of other vector and pathogen proteins that are involved in transmission of pathogen or vector colonisation and they would be potential candidates for vaccination or therapeutic strategies. Research at this level

allows primary interactions to be explored, which can be adapted to various vector borne diseases.

Hovius, J.W.R. et al (2007) Trends in Parasitology 23 (2007) 434-438

A study was published to assess and describe the current spectrum of emerging zoonoses between 2000 and 2006 in European countries. A computerized search of the Medline database from January 1966 to August 2006 for all zoonotic agents in European countries was performed using specific criteria for emergence. Fifteen pathogens were identified as emerging in Europe from 2000 to August 2006: including *Rickettsiae* spp., *Anaplasma phagocytophilum*, *Borrelia burgdorferi*, *Bartonella* spp., *Francisella tularensis*, Vorou, R.M et al. Epidemiology and Infection 135(2007) 1231-1247.

In March 2007, cutaneous nodules were observed on the neck, shoulder, and back of a breeding bull imported from France in November 2006. The nodules opened spontaneously and produced a haemorrhagic exudate. The cause was *Parafilaria bovicola*, a filariid nematode not endemic to the Netherlands. The worm can cause substantial economic loss because of the need to trim carcasses and because of the diminished value of hides. The infection is spread by the fly *Musca autumnalis*, which is common in the Netherlands. Because treatment does not stop the infection from spreading, the bull was culled to prevent the risk of infection of the national herd. To our knowledge, this is the first case of *Parafilaria bovicola* in the Netherlands.

Van Wuijckhuise, L. et al. Tijdschrift Voor Diergeneeskunde 132(2007) 820-824.

Fasciola hepatica

Pathology

A survey conducted in an abattoir in Lima, Peru associated fibrosis of the liver with an increase in numbers of fluke parasites present. This was a histopathological investigation measuring diffuse fibrosis (cirrhosis) of the liver with the mean number of *Fasciola* sp. parasites counted in the liver.

Luis, A M et al. J Helminthol 81(2007) 381-6.

Epidemiology

A Spanish survey reported the use of genetic sequences of nuclear ribosomal DNA in 25 samples of *F. hepatica*, from 10 geographical regions of Spain. All showed little variation in their genetic make-up, and this technique may be a useful tool for studying population genetics of the parasite.

Alasaad, S. et al. Parasitology Research 101(2007) 1245-1250.

A paper by workers of the Liverpool School of Tropical Medicine used the PCR technique to distinguish between *Fasciola hepatica* and *Fasciola gigantica* in fluke species from England and from north west Africa. The test successfully distinguished between 10 samples of each species correctly, and this may be a useful in distinguishing between these 2 species.

McGarry, J. W. et al. Annals of Tropical Medicine and Parasitology 101(2007)

415-421.

Diagnosis

The only paper of significance was by Spanish workers who studied the use of a new capture ELISA for the sero diagnosis of sheep fasciolosis. They used a monoclonal antibody directed against the excretory/secretory antigen of the parasite, which detected infection even with very low numbers of parasites present. There was no cross-reaction detected to other cestode and nematode parasite antigens. A commercial version of this test is now available from the diagnostic company BIO X.

Mezo, M. et al *Journal of Parasitology* 93(2007) 65-72.

Zoonotic Infection

A case of human hyper infection with *Fasciola hepatica* was described a paper where acute and chronic manifestations of fasciolosis co-existed in one patient in Peru. The diagnostic approach and treatment, with emphasis on control strategies were described in this paper.

Arauco, R. et al. *Foodborne Pathogens and Disease* 4(2007) 305-312.

A survey in the south west of France was conducted to detect human infection with *F. hepatica*. Between 1981 and 2004 there were 37 cases of human *F. hepatica* infection. Patients were treated with triclabendazole. Five of these required a second double strength dose to eliminate infection.

Dauchy, F. A. et al *Presse Medicale* 36(2007) 1545-1549.

An antigen ELISA for diagnosing *F. hepatica* infection in humans was described in a paper by Peruvian workers. The test was applied to populations in 3 Andean regions where there was endemic human infection with *F. hepatica*. In the 3 regions described, the prevalence of infection in was between 27 and 29%.

Espinoza, J. R et al. *American Journal of Tropical Medicine and Hygiene*. 76(2007) 977-982.

Another similar paper of seroprevalence in humans in northern Bolivia showed that in one region of this country 67% of the indigenous people were infected *F. hepatica* and that infection became endemic in 1984. There was an age related prevalence with highest infection in children aged between 8 and 11 years.

Parkinson, M. et al *Epidemiology and Infection*. 135(2007) 669-674.

Immunology

Irish workers published an important paper pertaining to co-infection with *F. hepatica* and *Mycobacterium bovis* last year. This dealt with the hypothesis that *F. hepatica* infection alters responses to diagnostic tests for bovine tuberculosis. The parasite has the ability to polarise the host's immune response to a Th2 response, which is known to inhibit the host's response to

other bacteria including bovine tuberculosis. The results of their experiments indicated that *F. hepatica* infection may interfere with the skin diagnostic test, but further work was required.

Flynn, R. J. et al. *Infection and Immunity*. 75(2007) 1373-1381.

A similar paper by Spanish workers indicated that even advanced chronic fasciolosis could interfere with the hosts' immune response to other infections. It is known that there is immune suppression in the host in the early phases of *F. hepatica* infection but this paper also demonstrated that even in advanced chronic infection this immune suppression continues.

Girones, N. et al *Journal of Infectious Diseases*. 195 (2007) 1504-1512.

A very interesting paper by Polish workers indicated that their work on vaccine production may produce an effective product against *F. hepatica*. They selected cysteine proteases, which play a key role in parasite feeding and migration, and produced a recombinant antigen that could be produced from *E.coli*. This antigen was then administered as an enteral vaccine in rats against fasciolosis. Their results indicated a 78% to 80% protection against challenge with fluke metacercariae. There was a significant increase in production of CD8 and CD4 lymphocytes in infected rats.

Kesik, M. et al. *Vaccine*. 25(2007) 3619-3628.

A paper including Peter Brophy (Professor at Aberystwyth University) investigated the comparative proteomics of excretory secretory proteins released by *F. hepatica*. This study provides an understanding of the host-parasite interaction and offers targets for chemo-and immunotherapy. These proteins are produced by *F. hepatica* and released in the host's bile. Time course *in vitro* analysis confirmed cathepsin L proteases as the major constituents of the *in vitro* ES proteome. The study highlighted difficulties with identifying authentic excretory/secretory protein products in *in vitro* experiments but confirmed that these proteins are good targets for therapeutics in future.

Morphew, R. M. et al. *Molecular & Cellular Proteomics* 6 (2007) 963-972.

Therapeutics

Following on from the identification of cystein proteases (excretory/secretory products), identified in the last paper, the use of cystein protease inhibitors as potential therapeutic agents, were attempted by a group of Spanish workers. They found that serum activities of these protease enzymes in infected animals were significantly lower in sheep treated with the protease inhibitor Ep-475, than in untreated sheep. There was still significant liver damage, however, and no significant reduction in total fluke burden observed in treated and untreated sheep. They concluded nevertheless that protease inhibitors were a potential for pharmacological intervention against *F. hepatica*.

Alcala-Canto, et al *Parasitology Research*. 100 (2007) 461-465.

A paper by Argentinean workers described the importance of understanding the processes that regulate drug transfer into helminth parasites in improving control of parasites. The lipophilicity of the anthelmintic was a major factor in determining how the drug entered the target parasite.

Alvarez, L. I. et al. Trends in Parasitology. 23(2007) 97-104.

Workers in Belfast produced a number of papers on flukicides. A review was produced by Peter Brophy et al describing progress in understanding the mechanisms of resistance to triclabendazole – the most widely used flukicide for 20 years, and now used in human therapeutics. The review also considered other options for choice of flukicides including alternatives to triclabendazole because of reports of resistance to this compound. Drug combinations and research for new compounds were described.

Brennan, G. P. et al. Experimental and Molecular Pathology. 82(2007) 104-109.

Two of the alternatives to triclabendazole (TCBZ) were also discussed in a further paper by Ian Fairweather (of the Queen's University, Belfast). They were Artemether and OZ 78. Both these potential flukicides performed better than TCBZ in an *in vivo* trial using rats experimentally infected with either TCBZ resistant or sensitive strains of *F. hepatica*. They were said to possess good fasciocidal properties against TCBZ resistant flukes.

Keiser J. et al. Trans R Soc Trop Med Hyg. 101(2007) 1219-22.

Another potential fasciolocide is compound alpha. A paper by Fairweather et al discussed ultra-structure changes in the outer layer of four week old *F. hepatica* following *in vitro* treatment, using both scanning and transmission electron microscopy. The sulphoxide metabolite of this compound caused disruption of the tegument.

Mcconville, M. et al. Parasitology Research. (2007) 100 365-377.

Another paper by workers at the Queen's University, Belfast investigated ultra structure changes in the tegument and of the gut of *F. hepatica* following treatment with nitroxynil. Examination of treated flukes histologically indicated that uptake of this flukicide was by the oral route only.

Mckinstry, B. et al. Parasitology Research. 101(2007) 929-941.

A similar paper from the workers in Belfast examined the ultra structure effects of the combination of triclabendazole and clorsulon using transmission electron microscopy. They demonstrated that there were additive effects using both of these flukicides and suggested that drug combinations would be of value in treating triclabendazole resistant flukes by this method.

Mckinstry, B. et al. Parasitology Research. 101(2007) 929-941.

PARASITIC GASTRO-ENTERITIS

General

There were several papers published in 2007 on the effects of parasitism with helminths (helminthiasis) on immunity. Concurrent helminth infection can alter

optimal vaccine-induced responses in humans and livestock. Some experimental work was presented but the authors admit that further studies are urgently needed.

Urban J F Jr. et al. *Veterinary Parasitology* 148 (2007) 14-20

The importance of the immunoregulatory effect of helminth infection and its consequences for the severity of other conditions as well as immunisation responses has led two authors to state that the parasitological criterion of hosts being egg positive or negative is too simplistic for this work and immunological analysis has also to be carried out.

Markus, M.B and Fincham, J.E. *Trends in parasitology* 23 (2007) 517-519

Interestingly, the role of helminths in suppressing some diseases in humans was also discussed this year. Colonization with helminths alters immune reactivity and protects against some immune-mediated diseases

Elliott, D. E. et al. *International Journal for Parasitology*. 37(2007) 457-464

Nematode parasite control

Updates on an EU funded international project 'PARASOL' were given at the WAAVP conference in 2007. Targeted selective treatment is being investigated and is likely to be based on weight gain using electronic weighing facilities of tagged sheep (condition scoring being found to be too inaccurate and insensitive). In cattle, pepsinogens in first season-grazing calves or milk ELISAs results in dairy cattle will be assessed. Ring testing of pepsinogen assays, larval development tests in liquid and agar gel and egg hatch assays will also be carried out.

Jackson, F. et al In Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 033 p146

Vercruyssen, J. et al In Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 034 p146

Wolstenholme, A et al. In Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 035 p147

Anthelmintics

The effects of Emodepside (a cyclooctadepsipeptide, already launched as a new class of anthelmintic, currently only licensed for cats) were studied on *Haemonchus contortus*, *Ostertagia ostertagi* and *Cooperia oncophora*. Emodepside was not ovicidal *in vitro* but it did inhibit larval development and larval migration. Its mechanism of action is not fully understood, but it appears to act on receptors to release neuro-transmitters, which induces a flaccid paralysis of the pharynx and somatic musculature of the parasite.

Schurmann, S. et al. *Parasitol Res* 101(2007) S45-56

Novartis announced at the 21st International Conference of the WAAVP in Ghent, the development of a new class of anthelmintics, amino acetonitrile derivatives (AADs). One product has been found to be biologically active against adult *Trichostrongylus colubriformis* and *H. contortus* in sheep and *H. contortus*, *Trichostrongylus sp* and *Oesophagostomum sp* in cattle. It also has

activity against benzimidazole and levamisole resistant parasites. *In vitro* studies show it causes a spastic paralysis. It doesn't have activity against the cestode *Moniezia* sp. however. They expect at least one of this group to come onto the market for cattle and sheep (but when?) and studies are continuing to look for flukicide action. Anthelmintic activity is expected to be >98% based on egg counts and the dose limiting species are *Cooperia curtecei* and *Nematodirus spatiger*.

Parasitic gastro-enteritis in sheep

The potential for improving welfare standards and productivity in United Kingdom sheep flocks using compulsory veterinary flock health plans was the subject of a paper published in 2007. The authors contend that targeting resources to specific diseases that have a proven benefit : cost ratio >1.0 as well as a scientifically proven solutions will more readily achieve compliance. An integrated policy for control of parasitic gastro-enteritis is included in the list of husbandry practices and disease proposed in the flock health plan. Estimates of costs of implementing the proposed plan are shown to be less than the present average cost to farmers for veterinary fees and medicines. Scott, P.R. et al. *The Veterinary Journal* 173 (2007) 522-531

The number of eggs from gastrointestinal nematodes per gram of faeces (worm egg count, WEC) is commonly used to determine the need for anti-parasite treatments and the breeding value of animals when selecting for worm resistance. Diarrhoea increases faecal moisture and may dilute the number of worm eggs observed. To quantify this effect, egg counts in sheep at pasture were simulated by dosing 15 animals with chromic oxide particles. The simulated WEC diminished as faecal moisture increased. The results suggest that adjustment for faecal moisture may provide an improved estimate of FEC and investigate the use of a correction factor for faecal consistency (FCS). They conclude that the impact of adjustment of observed WEC for faecal moisture predicted by FCS on decision points for treatment and on estimated breeding values requires further examination. Le Jambre, L.F. et al. *Veterinary Parasitology*, 145 (2007) 108-115

A paper was published that showed that low bodyweight is a predisposing cause of high *Trichostrongylus colubriformis* and *Haemonchus contortus* burdens and egg counts in Merino lambs. They conclude that if the goal is to ensure that lambs develop immunity before weaning, then every endeavour should be made to achieve the combination of critical bodyweight and exposure to moderate levels of nematode infection as soon as possible. McClure, S. J. and Emery, D. L. *Australian Veterinary Journal*. 85(2007) 437-445.

A study of farmer opinion and practice relating to control of gastro-intestinal nematodes on sheep farms in New Zealand concluded that dependency on anthelmintics continues to be high and the number of drench treatment has changed little over the last 25 years, but more persistent treatments are now used. Only 31% of farms had previously tested for drench resistance, effective quarantine treatments were not always carried out, but the use of faecal egg

counting had increased.

Lawrence, K. E. et al New Zealand Veterinary Journal. 55 (2007) 228-234.

Teladorsagia circumcincta

Parasitic nematodes must be able to withstand moderately high temperatures in both free living and parasitic stages. In the upper few cm of soil, where sheep parasitic nematodes have been reported, the temperature can exceed the ambient air temperature by several degrees Celsius. However, such periods of relatively high temperature are quite brief and the diurnal temperature range declines with increasing soil depth. In contrast, the temperature in the ovine abomasum and rumen is consistently high (38–41 °C). This means that sheep parasitic nematodes present in the soil or on the pasture must be able to withstand transient high temperatures, and those ingested by the animal must be adapted to sustained high temperature.

This study showed that L3 *Teladorsagia circumcincta* survived for at least 90 min at 45 °C *in vitro* in water, but only slightly higher temperatures inactivated the larvae rapidly.

Walker, L. R. et al Veterinary Parasitology. 146 (2007) 77-82.

Work on the development of free living stages of *T. circumcincta* at varying temperatures by workers in New Zealand has shown that the optimal temperature for development to L3 was 17 °C reducing to minimal at 4 °C and 37 °C (17°C in UK is a high average temperature for the summer)

Abdalla M. E. and Pomroy W. E. In, Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 205 p232

It is well established that dietary protein supply can influence the peri-parturient breakdown of immunity to nematode parasites but the importance of exposure to nematode larvae during pregnancy for this response was investigated in a paper published in 2007. The effects of giving a vaccinating dose with a trickle mixed infection of *Teladorsagia circumcincta* and *Trichostrongylus colubriformis* larvae (L3) to ewes being fed with different levels of metabolisable protein (MP) was investigated. Vaccinating infection delayed the peri-parturient rise in faecal egg count (FEC) by an average of 2 weeks but its effect on FEC during the first 6 weeks of lactation was smaller and less persistent than that of dietary MP supply and single- v. twin-suckling. This work supports the conclusion that availability of MP supply influences the recruitment and activity of cells of the immune armory of the gastro-intestinal tract to nematode parasites. The precise outcome may differ with site and/or nematode species.

Sykes, A. R. et al. Animal. 1(2007) 249-260.

Haemonchus contortus

The cause of ill thrift and deaths was investigated in a group of 40 Scottish low ground ewes, which had been treated with levamisole and then turned onto clean grazing after lambing. Concurrent haemonchosis and teladorsagiosis were diagnosed, putatively associated with the spring maturation of large numbers of hypobiotic larvae. Ill thrift due to parasitic

gastro-enteritis consequently occurred in the lambs, which had been turned onto the 'clean' grazing with their dams, despite metaphylactic anthelmintic treatments. The contributory role of haemonchosis resulting in serious production-limiting disease is unusual in Scottish sheep flocks. It is suggested that the problem may have arisen as a consequence of the adaptation of *Haemonchus contortus* to survive overwinter in a cold climate as arrested early fourth stage larvae, which were not eliminated when the ewes were treated with levamisole at turnout.

Sargison, N.D. et al. *Veterinary Parasitology*, 147 (2007) 326-331

Studies in Australia indicate that moisture conditions soon after faecal deposition are key determinants of *H. contortus* development success, with significant penalties on development when simulated rainfall was applied 7 days or more post-deposition, and when the duration of simulated rainfall was short. High rates of evaporation during both summer experiments resulted in rapid drying of the microenvironment and this appeared to have limited development to L3.

The susceptibility of *H. contortus* pre-infective stages to desiccation is well known. This tends to limit its distribution to areas with warm, moist summers and creating a natural barrier to development that results in sporadic development of the free-living stages. The sporadic nature of development is compensated for however, by the fecundity of *H. contortus*, which means that under continuous stocking of pasture, short periods of favourable conditions for development generally produce significant numbers of L3.

O'Connor, L. J. et al *Veterinary Parasitology*, 146 (2007) 90-101

A rapid, semi-quantitative penside test for detecting blood in faeces of sheep infected with *H. contortus* was described by workers in Australia. The test is best performed on fresh faeces collected from the ground and takes approximately 40 minutes. Infection is detected by day 11 of infection, well before eggs are detected. A drench decision guide was also provided with this test.

Besier R. B. et al. In, Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 205 p232

Work on a vaccine for *Haemonchus contortus* is the most advanced of all the gut nematodes, however more work needs to be done.

An experiment was conducted to determine whether any synergistic activity could be detected between an experimental vaccine and anthelmintic treatment against a drug resistant strain of *Haemonchus contortus*, i.e. would the combined effect of both interventions be greater than the sum of either alone. It was concluded that there was no evidence for synergy between a gut membrane protein vaccine and ivermectin or fenbendazole against an anthelmintic resistant isolate of *H. contortus*.

Smith, W.D. *Veterinary Parasitology*, 148 (2007) 356-359

Investigations into *Haemonchus contortus* cysteine proteases as potential candidates for immunological control of haemonchosis in goats showed that it conferred some protection against *H. contortus* in this host

Muleke, C. I. et al. *Small Ruminant Research*. 73 (2007) 95-102.

Nematodirus battus

New research into *Nematodirus battus*, (a parasite that is thought to have originated in the arctic) has shown

- that there is an upper as well as a lower temperature threshold for hatching and
- depending on the temperature, up to 70% of the population will hatch without chilling,
- but there is variation between field isolates.

Analysis of VLA VIDA data indicates that it is likely that climate change will lead to a less predictable, more all year- round pattern of outbreaks in the UK. Van Dijk, J and Morgan, E In Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 232 p246

Anthelmintic resistance in sheep

Multiple resistance to benzimidazole, imidazothiazole and macrocyclic lactone anthelmintics is an emerging problem in the southeast of Scotland. The general management and nematode control strategies employed in four affected flocks (flocks 1–4) were investigated in an attempt to identify the risk factors which might have led to the appearance of production limiting disease associated with anthelmintic resistance.

The important risk factors for multiple anthelmintic resistance could not be confirmed. It seems likely that different risk factors were involved in the four flocks. Lambs in flocks 1 and 2 had been treated with an anthelmintic at 3–4 weekly intervals with the aim of achieving suppressive nematode control, while sheep in flock 1 had been treated with an anthelmintic after they were moved onto clean grazing. Recently lambed ewes had been treated with moxidectin in three of the four flocks, with the aim of controlling their periparturient rise in faecal nematode egg output. All of these factors might have contributed to the emergence of multiple anthelmintic resistance, because they could have led to anthelmintic treatments at times when the nematode population in refugia was small, compared to that in the sheep. Annual rotation of the anthelmintic group was compromised by the emergence of benzimidazole resistance and did not prevent the emergence of multiple resistance in any of the flocks described, although the practice may have slowed the development of resistance. Underdosing may have selected for benzimidazole and imidazothiazole resistance in flock 2, associated with inaccurate estimation of the weights of terminal sire lambs.

Sargison N.D. et al. *Veterinary Parasitology*, 145 (2007) 65-76

Multiple resistance in *T. circumcincta* in a sheep flock in the south east of Scotland was described in 2007, including resistance to long acting moxidectin. It was postulated that the persistent period of activity of moxidectin would have killed moxidectin susceptible nematodes but allowed ML resistant larvae and adults to survive, which would have given them a significant advantage in populating the pasture, if numbers in refugia were low.

Wilson, D. and Sargison N. Veterinary Record. 161(2007) 535-536 (letter).

Investigation into sheep farms in north east of Scotland however has not detected significant problems with anthelmintic resistance and it was suggested that this warrants further research. However the small size of the sheep enterprises together with a high percentage also keeping cattle and growing barley would allow ample opportunity for field rotation, which is likely to have a significant, beneficial, effect.

Brown, R. Veterinary Record. 161(2007) 668 (letter).

A faecal egg count reduction test was conducted on a sheep farm in the Netherlands, with suspected avermectin resistance. Five groups of 10 sheep were formed. Group 1 was the untreated control group. Groups 2–5 were treated according to weight with the recommended dose of, respectively, levamisole, doramectin, moxidectin or albendazole. Resistance was found in the sheep treated with doramectin (15% efficacy) and albendazole (87% efficacy). Levamisole and moxidectin were 100 and 99% effective, respectively. Larval identification of the faecal cultures of the doramectin treated sheep revealed 100% *Haemonchus contortus* larvae. After albendazole treatment, 77% of the cultured larvae were *H. contortus* and 23% *Teladorsagia/Trichostrongylus* sp.

Borgsteede F.H.M et al Veterinary parasitology 144 (2007) 180-183

Anthelmintic resistance in gastrointestinal nematodes among small ruminants is widespread in South Africa and Dorper sheep and Boer goats have been imported into Switzerland from this country on a number of occasions. According to the faecal egg count reduction test (FECRT) avermectin resistant gastro-intestinal nematodes were confirmed in 7 of the 24 Boer goat farms and suspected in a further 8 farms. Likewise avermectin resistance was confirmed in 2 of 12 Dorper sheep farms and suspected in a further 6 farms. *Haemonchus contortus* and *Trichostrongylus* spp. were the dominant resistant species according to larval cultures. There was no indication of levamisole resistance. The results indicate that avermectin resistance is widespread in Swiss small ruminant farms keeping Boer goats and Dorper sheep. The common tradition of grazing animals from different farms on prealpine and alpine pastures could favour the spread of resistant populations within the country. (Similar risks to common grazing in UK)

R. Artho, et al. Veterinary Parasitology, 144 (2007) 68-73

A very interesting paper was published in 2007, where workers in France replaced benzimidazole resistant nematodes on pasture (the proportion of benzimidazole-resistant worms in the paddocks ranged from 20% to 89%). A 2-step replacement was performed: first, the paddocks were not grazed for 6 months (from December to July), and then the grass was cut to eliminate any residual infective larvae, before contaminating each of the paddocks with 10 seeder lambs experimentally infected with a benzimidazole-susceptible strain of *T. circumcincta* from July to November. At the end of the experiment, all the populations on the paddocks were phenotypically benzimidazole-susceptible, but genotyping indicated that 2 populations harboured 1% and 3% resistant worms respectively. This study demonstrates that nematode replacement is

feasible in temperate areas, using semi-intensive stock management, even when the initial levels of benzimidazole-resistance are very high. Further research should next assess replacing the whole community to cope with the species diversity observed under field conditions.

Moussavou-Boussougou, M. N. et al *Parasitology*. 134 (2007) 553-560.

Farms were tested for the presence of Macrocyclic lactone anthelmintic resistance in one area of New Zealand. Resistance to ivermectin was detected on 22/47 farms (47%). The prevalence of resistance was lower on farms on which management practices, particularly those of lambs, maintained refugia of unselected nematodes.

Hughes, PL et al *New Zealand Vet Journal* 55 (2007) 177-183

Detection of anthelmintic resistance

In vivo methods

New Zealand workers examined the use of composite worm egg counts in faecal egg count reduction tests. They show that although there are occasions when their use could produce misleading results, these occurrences are comparatively rare. They may also allow greater numbers of animals to be included in the treatment groups at little extra cost, and potentially produce a more reliable result as a consequence.

McKenna P.B. *New Zealand vet journal* 55 (2007) 100-101

In vitro methods

A study comparing the egg hatch test (EHT) and the liquid larval development test (LDT) as *in vitro* tools for detection of benzimidazole (BZ) resistance in *Haemonchus contortus* was published this year. Comparisons were made during a course of infection and changes in both EHT and LDT were monitored to measure the correlation between resistance and susceptibility in different parasite stages (eggs and larvae). In addition, mixed doses of known numbers of susceptible and BZ-resistant *H. contortus* eggs were used to assess the sensitivity of LDT for the detection of low levels of resistance. The degree of resistance for each test was expressed as resistance factor (RF). The LDT showed a greater ability to distinguish between four susceptible and four resistant isolates of *H. contortus* with higher resistance factors compared to the EHT. The LDT was also able to clearly indicate the presence of low level (4%) of resistant larvae amongst a susceptible background population.

Várady, M. et al. *Veterinary Parasitology* 149 (2007) 104-110

Várady and Corba also presented work on *in-vitro* detection of macrocyclic lactone as well as benzimidazole resistance in *Haemonchus contortus* at the WAAVP conference in 2007. A liquid larval development test with use of LC₉₉ or minimum inhibitory concentrations was advised.

Várady M. and Corba J. In, *Proceedings of the 21st International Conference WAAVP, 2007 Ghent*. Abstract 165 p212

Ivermectin and moxidectin are closely related avermectin/milbemycin anthelmintics and available data suggest that side resistance occurs with these two drugs. However, moxidectin remains effective against many species of ivermectin-resistant worms due to its higher potency. The larval development assay (LDA) is routinely used by workers in the USA to diagnose ivermectin resistance in *Haemonchus contortus* but laboratory diagnosis of moxidectin resistance is hampered by the lack of any validated in vitro tests. The aim of the paper was to measure the relative susceptibility/resistance of *H. contortus* to moxidectin on goat farms in Georgia, and to validate the DrenchRite LDA for detecting resistance to moxidectin. Using statistical results, they were able to rank the nine farms from the least to the most resistant, and to develop a set of criteria for interpreting DrenchRite LDA results so that this assay can be used to diagnose both clinically apparent moxidectin resistance, as well as sub-clinical emerging resistance. Based on results of the LDA, moxidectin-resistant farms had resistance ratios, compared with an ivermectin-sensitive farm, ranging from 32 to 128, and had resistance ratios of 6-24 compared with an ivermectin-resistant/moxidectin naive farm. Moxidectin resistance was diagnosed both in *Haemonchus* sp and *Trichostrongylus* sp on almost half of the farms tested, despite this drug only being used on these farms for 2-3 years.

Kaplan, R. M. et al International Journal for Parasitology. 37(2007) 795-804.

Molecular methods

An international consortium has been set up to work towards the identification of single nucleotide polymorphism markers (SNPs) for anthelmintic resistance in helminths of veterinary and human importance. The aim is to develop sensitive and accurate tests for anthelmintic resistance, to study the origin and spread of resistance in the field and to monitor and evaluate strategies to manage resistance

Prichard, R. K. et al. Parasitology. 134(2007) 1073-1076.

Resistance to benzimidazoles has been recognized for a long period and hence research into it is more advanced than resistance to other anthelmintic classes. The primary mechanism is changes in the structure of beta-tubulin (building blocks of microtubules). Changes in amino acids at codons 167, 198 and 200 of the isotype 1 gene of beta-tubulin have been associated with benzimidazole resistance. The importance of each change appears to vary with species and geographical origin of the parasite. The same genetic determinants appear to be involved in BZ resistance in *Cooperia oncophora* in cattle.

There is growing interest in mass treatment of humans with benzimidazoles, for parasite control, which would make this work of increased importance, as lack of efficacy of benzimidazoles in human helminths has been described. PCR based assays have already been developed for genotyping resistant individuals or populations of worms. Further development of rapid tests to detect and track changes in these markers and other markers of resistance are required.

Samson-Himmelstjerna, G. Von et al. Parasitology. 134 (2007) 1077-1086.

A paper claiming a simpler method for detecting these changes was published in 2007. The use of a multiplex real time PCR method to provide estimations of resistance allele frequency in a population is described. It was able to detect small changes in the frequency of individuals resistant to benzimidazole within populations of *Haemonchus contortus*.

Walsh, T. K. et al. *Veterinary Parasitology*. 144(2007) 304-312.

Research on levamisole and pyrantel resistance is less well advanced than benzimidazole resistance. Levamisole and pyrantel act on nematode nicotinic acetylcholine receptors on somatic muscle cells. It has recently been found that there are numerous types of receptors in several nematodes. These are the product of several genes and can be modulated by several other proteins. Mutations altering these proteins could alter sensitivity of these receptors and lead to resistance. Resistance could therefore be polygenic in nature and the mutations may vary between species or between different resistant isolates of the same species.

Martin, R. J. and Robertson, A. P. *Parasitology*. 134(2007) 1093-1104.

Molecular studies in *Haemonchus contortus* however, have identified one candidate HA17 that was found in levamisole resistant nematodes from different isolates and not in susceptible ones. It is therefore a potential marker for levamisole resistance.

Neveu, C. et al. *Parasitology*. 134(2007)1105-1110.

Macrocyclic lactones act on ligand- (glutamate (GluCl) and GABA) gated chloride channels, but the mechanism whereby nematodes become resistant is not known, so molecular tests to detect resistance are not yet possible. Multiple gene changes are likely to be responsible for resistance. ML resistance can be selected for very quickly in some parasite populations, but not in all. This may be explained by the expression of non-specific detoxification mechanism, such as P-glycoprotein (P-gp), which might already have been induced by previous anthelmintic treatment. There is evidence that ivermectin and, to a lesser extent moxidectin, select for certain P-gp and other transporter genes, to cause over-expression, which can affect drug concentration within the parasite. Another non-ligand gated ion channel gene which appears to be under ivermectin selection, at least in *Haemonchus contortus*, is beta -tubulin. The further elucidation of these mechanisms is necessary before genetic markers for resistance can be detected.

Mccavera, S.; et al *Parasitology*. 134 (2007) 1111-1121.

Prichard, R. K. and Roulet, A. *Parasitology*.134(2007) 1123-1132.

Further evidence for P-gp transport mechanisms being involved in ivermectin resistance was given by work presented at the WAAVP conference in 2007. Workers at the Moredun reported that the use of P-gp inhibitors reduced the amount of ivermectin needed to effect resistant nematodes *in-vitro*.

Bartley et al In Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 076 p167

Alternative Parasite control

The search for alternatives to chemical control of parasites continues. Numerous studies continued to be published into the use of nematode trapping fungi, nematocidal bacteria, alternative forages containing condensed tannins and use of other plants with possible anthelmintic activities. Results vary from paper to paper and with different parasite species. Those showing most promise are, at best, likely only to be used with other methods of parasite control.

A field study was conducted on three Swiss farms to investigate the efficacy of *Duddingtonia flagrans* against naturally acquired infections of gastrointestinal nematodes in adult dairy sheep. At an overall moderate infection level in all farms *D. flagrans* did not have a significant effect on the observed parasitological parameters with the exception of significantly reduced herbage infectivity in one farm. In contrast, the results from faecal cultures indicated a mean suppression of larval development during the fungus-feeding period between 82, 89 and 93% on the three farms, respectively. The discrepancy observed between the fungus efficacy in coprocultures and on pasture, which was also observed in several other studies, deserves further research.

Faessler, H. et al. *Veterinary Parasitology*, 147(2007) 96-102

Duddingtonia flagrans was successful in trapping larvae of *Haemonchus contortus* in temperatures mimicking that seen at lambing in Australia. The lowest trapping efficacy of 80% was seen in temperatures 6-19° C, (temperatures slightly higher than usually seen in Spring in UK). The problems of daily administration (but this may be possible in the lambing ewe) and the lack of a commercial product containing this fungus still remain.

Kahn, L. P. et al. *Veterinary Parasitology*. 146 (2007) 83-89.

The direct anthelmintic effects associated with the feeding of fresh tanniferous forages against established populations of *Haemonchus contortus* and *Cooperia curticei* in lambs was investigated. The effects of grazing chicory (*Cichorium intybus*), birdsfoot trefoil (*Lotus corniculatus*), sainfoin (*Onobrychis viciifolia*) or a ryegrass/lucerne mixture (control) were studied. When compared to the control, administration of all tanniferous forages was associated with significant reductions of total daily faecal egg output specific to *H. contortus* and a tendency of reduced *H. contortus* worm burden. Irrespective of the condensed tannin (CT) containing fodder, no anthelmintic effects were found against *C. curticei*. Overall, birdsfoot trefoil and in particular sainfoin seem promising candidates in contributing to an integrated control strategy against *H. contortus* not only by mitigating parasite related health disturbances of the host but also by a sustained reduction of pasture contamination.

Heckendorn, F. et al. *Veterinary Parasitology*, 146, (2007) 123-134

The potential for a nematocidal *Bacillus thuringiensis* (Bt) to target the free-living larval stages of *Haemonchus contortus* was examined using *in vitro*

larval development and migration assays. Several isolates of the bacterium *Bacillus thuringiensis* (Bt) are highly toxic to larvae and adults of *Haemonchus contortus*, *Trichostrongylus colubriformis* and *Ostertagia circumcincta* *in vitro*, thereby indicating that this group of bacteria may hold some promise as anthelmintics. Targeting the larvae, by delivering bacterial spores to the faeces through the host animal's digestive tract, would require a period of bacterial development will introduce a time lag between worm egg hatching and initial exposure of the larvae to the Bt. This study demonstrated that this may allow the worm larvae to develop to late larval stages, which are relatively insensitive to the toxin.

O'Grady, J. et al *Veterinary Parasitology*. 150(2007) 97-103.

Breeding for resistance to parasites

A review that summarises the current state of knowledge of the genetic control of resistance to infectious and metabolic diseases in small ruminants was published in 2007. Diseases covered include gastrointestinal nematode infections and ectoparasites such as flies and lice. In all cases there is well-documented evidence for between-animal genetic variation in resistance to these disease and, in the case of some of the infectious diseases, resistance to infection. These heritable differences between animals lead to opportunities to breed animals for enhanced resistance to the disease. The feasibility of breeding for resistance has already been demonstrated in experimental flocks. For some diseases, including nematode parasite infections, there are now concerted efforts to find genetic markers associated with resistance to infection, potentially allowing selection for increased resistance in the absence of infection. It is likely that integrated studies combining quantitative and functional genomics, large-scale data collection (both within and between breeds) and epidemiological prediction will lead to new opportunities for breeders to select sheep and goats for enhanced resistance to a variety of diseases.

Bishop S.C. and Morris C.A. *Small Ruminant Research*, 70 (2007) 48-59

The interaction between sheep and the nematode *Teladorsagia circumcincta* is one of the best understood of all host parasite interactions. Following infection, there is considerable variation among lambs in the number of nematode eggs produced, the number of early fourth-stage larvae and the number of adult worms in the mucosa. These traits have a high variance to mean ratio (i.e. they are overdispersed or aggregated among hosts), they are skewed and approximately negative binomially distributed. The sources of overdispersion are differences among lambs in the ingestion of infective larvae and the immune response. Both forces can produce aggregation but their relative importance is unknown. The key components of variation can be identified by variance analysis. The sum of the average effects of polymorphic genes is known as additive genetic variation and this increases essentially from zero at one month of age to quite high values at six months of age. The major mechanism underlying genetic variation appears to be the differences among individuals in immune responses. Two of the major sources of variation in immune responses are differences in antigen recognition and differences in the type of cytokines produced. Genes that influence both these

sources of variation are associated with differences in resistance to nematode infection. Therefore, much of the heterogeneity among animals in parasite transmission appears to be due to genetic variation in immune responsiveness.

Stear, M. J. et al *Journal of the Royal Society Interface*. 4(2007) 767-776.

Livestock breeding programmes have created resistant (R) and susceptible (S) sheep that differ in their ability to control parasites through their immune function but potentially also their grazing behaviour (i. e. parasite avoidance). A study concluded that selection for genetic resistance has resulted in animals that, despite being well armed to fight parasitism through improved immune function, adopt parasite avoidance strategies with associated nutritional disadvantages. This experiment highlights the role of host behaviour in the control of parasitism and suggests that animals can be bred to avoid disease.

Hutchings, M. R. et al. *Proceedings of the Royal Society B-Biological Sciences*. 274(2007) 1839-1844

Mathematical Models

Mathematical models are being actively researched as

- a tool to evaluate the consequences of differing management strategies and environments, such as breeding for certain traits associated with resistance and nutritional strategies, on the consequences of gastrointestinal parasitism in sheep, (Vagenas, D. et al. *Parasitology*. 134(2007) 1279-1289)
- looking at the effect of these parasites on the liveweight performance of individual young sheep. (Louie, K. et al *International Journal for Parasitology* 37 (2007) 233-241).
- Producing on farm advice to veterinarians and farmers for worm control (Taylor M.A. et al In *Proceedings of the 21st International Conference WAAVP, 2007 Ghent*. Abstract 231 p246)

Parasitic gastro-enteritis in cattle

General

A detailed study of the epidemiology of subclinical nematode infections in adult dairy cows was conducted on five well-managed English dairy farms during the 2002 grazing season. These same farms had also participated in a similar study in 1978–1979 and thus provided a unique opportunity to compare the epidemiological findings after an interval of over two decades. Subclinical roundworm burdens, as judged by faecal egg counts, were widespread in dairy cows in 2002, but the prevalence of animals with patent infections and the magnitude of the worm egg output were significantly lower than in 1978–1979. (In the present study, 37.7% of lactating cows were found to harbour patent strongyle infections during the grazing season. This was significantly lower than that recorded in the earlier study in which 85.2% were

found to harbour subclinical burdens. Worm egg output was also significantly lower at just 1.0 e.p.g. compared with a mean 4.5 e.p.g. in the previous study) Pasture larval numbers were, however, nearly three times higher in 2002 with *Ostertagia* sp dominating the nematode genera to which cows were exposed at pasture in both surveys. It is possible that immunity limited the worm egg output in these animals. Factors considered likely to account for differences in parasite epidemiology include the marked increase in herd productivity over the intervening period, the increased proportion of Holstein genetics with the consequent increase in milk yield and feed intake, changes in grassland management and increased stocking rate seen on the majority of farms. Fox, M. T. et al. *Veterinary Parasitology*. 146 (2007) 294-301.

Studies on a commercial beef farm in south Sweden showed that spring turnout of first season grazing calves, in May, onto pasture that had had second year grazing animals in the previous autumn, with a movement to silage aftermath in mid summer exposed the animals to fewer parasites. The silage aftermath was found to be virtually parasite free due to a reduction in overwintered larvae by mid June, and by cutting the silage. No anthelmintics were given to these first year grazers for the 3 consecutive years of this study. However it was advised that care must be exercised if the same turnout pasture is used for first season grazing cattle every year. Meteorological factors could also alter the effects, and allow more parasite exposure early on in the grazing season, or reduce the beneficial effects of the second year grazing calves

Larsson, A. et al *Veterinary parasitology* 145 (2007) 129-137

Information on decision trees for worm control in cattle (and sheep and horses) used in the Netherlands was presented at the WAAVP conference in 2007. These are available to farmers and veterinarians. The advantage of these is that it produces a farm specific advice, based on grazing management, rather than general recommendations.

Eysker M et al In Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 318 p291

Parasite control in cattle

Anthelmintics

A long acting moxidectin injection has recently been introduced for cattle in the UK. The high lipophilicity of moxidectin combined with the long acting injectable formulation accounts for its wide distribution and long residence time in treated cattle. Moxidectin was first detected at 1 h after treatment in plasma and at 2 days in hair. Although plasma concentrations were lower than those found in hair, the disposition of moxidectin in plasma and in hair follow a similar pattern. Furthermore the relative high concentrations of moxidectin in hair could explain the high efficiency of this class of compound against external parasites.

Dupuy, J et al. *Veterinary parasitology* 147 (2007) 252-257

One hundred and nineteen herds in Flanders (Belgium) were randomly assigned to a treatment with eprinomectin or a placebo in October 2004. Bulk milk *Ostertagia ostertagi* ELISA tests were carried out on all farms, with results expressed as OD ratios (ODR). Herds in the highest pre-treatment ODR category (>0.84) had a positive milk-yield response of 4.0 kg/cow/day (95%-confidence interval: 1.0; 7.0), while the 95%-confidence intervals of the milk-yield responses in the other categories all included zero.

This study demonstrates that treatment with eprinomectin of pastured dairy cows in autumn in this area will lower the *Ostertagia*-specific bulk-tank milk antibody level during the housed period and can result in a consistent increase in milk yield. No effect on the milk-protein % or milk-fat % was observed.

Charlier, J. et al *Veterinary parasitology* 143 (2007) 322-328

A study in first year grazing heifers provides additional evidence for parasite-induced inappetence, manifest as a reduction in grazing time, but there was no evidence that parasitised cattle selectively grazed e.g. clover to compensate for the parasitism. However, the low level of parasitism in the control cattle and the high growth rates in both groups may have masked possible differences in selective grazing behaviour.

A.B. Forbes, et al *Veterinary Parasitology* 150 (2007) 321-332

A survey to determine the range of bulk milk antibody titres to *Ostertagia ostertagi* in Western Europe was presented at WAAVP conference. Variations appeared to be associated with access to pasture and seasonality.

Forbes, A. B et al. In, *Proceedings of the 21st International Conference WAAVP, 2007 Ghent*. Abstract 010 p 134

A seasonal pattern in both individual and bulk milk Anti-*Ostertagia ostertagi* Antibody Levels was observed in longitudinal studies in 2 dairy herds in France. This variation followed the expected intake of infective larvae i.e. the antibody levels increase during the grazing season and decline on housing. The effect that this may have on the bulk milk results that lead to advice on anthelmintic treatment needs to be assessed. The large variation in individual animals OD ratio results suggest that this would be a useful way to identify individual animals that need anthelmintic treatment, but the author admits that bulk milk and whole herd anthelmintic treatment are much more likely to be carried out.

Charlier, J. et al. *Research in Veterinary Science* 83(2007) 194-197.

Alternative parasite control in cattle

The viability of a formulation of *Duddingtonia flagrans* was assessed in the control of parasite gastrointestinal nematodes of cattle. The egg per gram of faeces counting the gastrointestinal nematodes showed a difference ($P < 0.05$) in the treated group in June, July and August, with reductions of 58% (June), 47% (July) and 51% (August) compared to the control group. At the end of the experimental period, the animals in the treated group had a greater weight gain ($P < 0.01$) compared to the untreated group. The treatment of cattle with pellets containing the *D. flagrans* nematophagous fungus, at the

dose and duration used, was effective in controlling the infective larvae of gastrointestinal nematodes of cattle in this experiment.

Dias, A. S. et al. World Journal of Microbiology & Biotechnology. 23(2007) 1245-1252.

Parasite vaccines

Work is continuing on a vaccine against *Ostertagia ostertagi*, looking at subfractions of the protective ES-thiol fraction. In this paper the cumulative faecal egg counts were reduced in vaccinated animals compared to controls, but no significant reductions in worm burdens were observed.

Meyvis, Y. et al Veterinary Parasitology 149 (2007) 239-245

Anthelmintic Resistance in Cattle

An ivermectin resistant *Ostertagia ostertagi* was created by repeatedly exposing the population to subtherapeutic and therapeutic concentrations of ivermectin over 10 generations. In the last generation, ivermectin reduced the faecal egg counts by 57% and 65% on day 7 and 14 post treatment compared to 100% in the parental, ivermectin susceptible, generation. This isolate will be used for further studies, as ivermectin resistance in cattle nematodes is being reported in several parts of the world (New Zealand and Argentina have reported *Ostertagia ostertagi* resistant to ivermectin) and it is likely to become more widespread.

Van Zeveren, A.M. et al. Veterinary parasitology 150 (2007) 104-110

A study into anthelmintic resistance in cattle in Germany, Sweden and Belgium, using faecal egg count reduction tests 7 and 14 days post ivermectin injection treatment was presented in 2007. In all three countries ivermectin inefficacy was detected. *Cooperia onchophora* was the predominant parasite detected post treatment, but *Ostertagia ostertagi* was also detected. The presence of nematodes refractory to ivermectin treatment was more common than previously realised. Further work will be carried out.

Demeler J. et al In Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract190, p224

A study was carried out on a number of large (mean 6760 cattle) fattening and cow-calf systems in a region of Argentina. Using faecal egg count reduction tests, ivermectin resistance was found in 15/25 cattle herds tested (*Cooperia* sp was predominant post treatment) and benzimidazole resistance in 8 herds (where *Ostertagia* sp was predominant post treatment). Resistance to both ivermectin and benzimidazole was found in 7 herds. No levamisole resistance was detected.

Anthelmintic treatment was given 4 times per year in herds with anthelmintic resistance, 2.1 times more than herds without anthelmintic resistance. The need for veterinarians and farmers to adopt nematode control strategies to conserve the efficacy of anthelmintics was stressed.

Suarez V.H. and Cristel S.L. Veterinary parasitology 144 (2007) 111-117

A study was carried out in the northwestern region of São Paulo State, Brazil, to determine the anthelmintic resistance status in naturally infected cattle with gastrointestinal nematodes. Faecal egg count reduction tests were used with larval differentiation of eggs present post treatment. Results indicated the presence of resistant *Cooperia* spp. and *Haemonchus* spp., especially to ivermectin. On some farms, resistance to albendazole and levamisole was also observed

Soutello, R.G.V et al Veterinary parasitology 148 (2007) 360-364.

An investigation into a cattle farm in the midwest of the USA, where a usually highly effective anthelmintic treatment programme resulted in poorer productivity, detected *H. contortus* resistant to both macrocyclic lactones and benzimidazoles and *Cooperia* sp resistant to macrocyclic lactones.

Gasbarre, L.C and Smith, L.L. In, Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 135 p197

Gastro-intestinal parasites of pigs

A study comparing modifications of the McMaster method for the enumeration of *Ascaris suum* eggs in pig faecal samples was published. Generally the more complex the method (i.e. involving centrifugation) the more sensitive. Based on the mean FEC for two chambers, an efficiency coefficient (EF) was calculated and equated to 1 for the highest egg count. It was suggested that efficiency coefficients make it possible not only to recalculate and unify results of faeces examination obtained by any method but also to interpret coproscopical examinations by other authors.

Pereckienė, A. et al. Veterinary Parasitology 149 (2007) 111-116

Comparison of the efficacy of two ivermectin formulations (an original and a generic formulation) against larval and adult *Ascaris suum* and *Oesophagostomum dentatum* (the two most common helminths in pigs) was published. *Oesophagostomum* spp. is the dose-limiting species for ivermectin. The study showed that a quality generic anthelmintic can provide a similar or, in some cases superior, level of parasite control as a pioneer product.

Borgsteede, F.H.M. et al Veterinary Parasitology 146 (2007) 288-293

Dictyocaulus viviparus

The development of a bulk milk ELISA test for detecting *Dictyocaulus viviparus* infection was described. The antibody detected was against a recombinant antigen derived from a major sperm protein present in sexually mature *D. viviparus* only. Experiments showed that after infection, milk antibody was above cut off levels by day 29 post infection and remained elevated for 68 days. Treatment prior to the parasites becoming adult did not lead to an antibody rise, confirming the specificity of the ELISA to adult worms. Treatment of an adult infection with anthelmintic, which stopped larval shedding, did not produce a reduction in antibody titre.

Strube, C et al. In, Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 009 p134

A case control study on outbreaks of lungworm on dairy herds in the Netherlands showed that

- zero-grazing of young stock only occurred on case farms,
- preventative treatment of yearlings prior to or during the grazing season occurred on twice as many case farms as control farms.
- all 4 farms that turned out their whole herd after 2 + years of zero-grazing subsequently experienced an outbreak within 2 years, the source of which could not be traced.

Feenstra P.B et al. In, Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 084 p 171

COCCIDIOSIS

Coccidiosis in poultry

Control

A paper “Revitalisation of anticoccidial sensitivity in poultry flocks by the use of a live attenuated vaccine” (Marshall et al, Proceedings of WAAVP 21st International Conference, Gent, Belgium, August 2007) reported that the use of Paracox-5 vaccine in poultry houses exhibiting anticoccidial resistance problems resulted in resistant oocysts being replaced with sensitive ones, so-called “Revitalisation”.

Another paper at the same conference “A field study assessing control of broiler coccidiosis by Paracox vaccination or by Baycox (toltrazuril) stand-alone treatment” (Claeskens *et al*) reported that Baycox was a valuable alternative to vaccination for coccidiosis control in a rotation programme. However, as the EU is reviewing the use of anticoccidial drugs this may have limited appeal!

Martin Shirley and colleagues at IAH Compton published a comprehensive paper entitled “Challenges in the successful control of the avian coccidia”, *Vaccine* 25 (2007), 5540 – 5547, in which they compared different current methods of control, and then proposed possible novel vaccination approaches for the future.

David Chapman from Arkansas University, USA investigated the use of low numbers of oocysts of *Eimeria maxima* to induce immunity in chicks reared on both new and reused litter. This is important in the US where they don't use the “All in, all out” approach to chicken husbandry, but it may possibly become more relevant to the UK if husbandry systems were to change. (Chapman, H D & Rayvarapu, *S Avian Pathology*, 36 (2007) 319 – 323).

Another paper from David Chapman in the States reported the emergence of coccidia from turkeys, which are resistant to Monensin. It is very probable that the situation is the same in the UK, and as the number of anticoccidial drugs for turkeys is limited, and there is as yet no vaccine available, this may have

serious implications for the future. (Chapman H D & Rathinam T Avian Diseases 51 (2007) 954 – 957).

The Dutch group from Lelystad investigated the immune responses to coccidial *Eimeria acervulina* infection in different lines of broiler chickens. They reported that faster growing chickens had a lower parasite load in their intestines than a slower growing strain. This has important implications for both immunity to challenge, and also possibly the way different chicken lines react to vaccination with live attenuated vaccines. Swinkels et al, Veterinary Immunology and Immunopathology 117, (2007) 26 – 34.

A paper from the USDA research laboratory in Beltsville, USA reported on the “Influence of *Pediococcus*-based probiotic on coccidiosis in broiler chickens”, (Lee et al, Poultry Science 86, (2007) 63 – 66). They reported that oocyst shedding was significantly reduced when this probiotic was utilised in the diet. A probiotic (“Aviguard”) is being marketed in the UK by Schering-Plough in order to exclude harmful bacteria, including *Clostridium perfringens*, which is associated with coccidiosis and necrotic enteritis.

Hermans and Morgan (University of Liverpool) produced a very detailed paper outlining the “Prevalence and associated risk factors of necrotic enteritis on broiler farms in the United Kingdom; a cross-sectional survey” (Avian Pathology 36 (2007) 43 – 51).

Technical

Morris *et al* from Melbourne, Australia reported on “The application of a polymerase chain reaction (PCR)-based capillary electrophoretic technique provides detailed insights into *Eimeria* populations in intensive poultry establishments” (Molecular and Cellular Probes 21 (2007) 288 – 294). They proposed that the use of these tools could help with epidemiology investigations into coccidiosis in poultry houses. VLA Weybridge is currently investigating the use of PCR techniques in the UK.

Coccidiosis in cattle

Workers confronted PMNs and monocytes with sporozoites of *E. bovis* to mimic the situation *in vivo*, and found that PMNs seem to eliminate sporozoites. The results suggest that PMN-mediated, innate immune reactions play a role in the early immune response of primary *E. bovis* infections in calves.

Hermosilla C. et al In Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 108 p183

Diclazuril dosed at 1mg/kg is as effective against *E. alabamensis* as against the more pathogenic species *E. bovis* and *E zuernii*

Veys P and Goossens, L. In, Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 110 p184

Recently, 2-stage weaning methods have been investigated as a means to reduce stress in calves. The objective of this study was to investigate the effect of weaning method on faecal oocyst count and *Eimeria* spp.

Composition. Rectal samples were collected on days 7, 28 and 42. Faecal oocyst counts did not differ between treatment groups on any sampling day. Clinical coccidiosis was not observed.

Lucas A.S. et al. *Vet Parasitology* 145 (2007) 228-233

A symposium took place in 2007 to coincide with the launch of BAYCOX BOVIS (active ingredient: toltrazuril)

Toltrazuril 5% oral suspension is registered by Bayer Animal Health for the prevention of *E. zuernii* and *E. bovis* in dairy replacement calves at a dose of 15mg/kg BW in a single oral treatment. Studies have shown that a single metaphylactic treatment with toltrazuril controls clinical coccidiosis and oocyst shedding under various field conditions when compared with Vecoxan (diclazuril) treated groups and control groups. It is recommended that metaphylactic treatment is commenced one week before symptoms are anticipated.

Deniz A. Bayer Symposium on Bovine Coccidiosis and Neosporosis, Glasgow 2007

Coccidiosis in pigs

Despite its economic and veterinary importance, interactions between the parasite and innate and the antigen-specific immune system of the host are still poorly understood. The authors were able to show infection-dependent changes in leukocyte populations during *I. suis* infections which reflect involvement of both innate and adaptive components of the porcine immune system. Moreover, the results from antigen-specific restimulation in vitro strongly suggest an adaptive immune response to *I. suis*.

Worliczek, H L et al. In, Proceedings of the 21st International Conference WAAVP, 2007 Ghent. Abstract 109 p184

Coccidiosis in new world camelids

An interesting paper describing a case of “Coccidiosis in British alpacas (*Vicugna pacos*)” was published by VLA colleagues in the *Veterinary Record* (160 (2007), 805 – 806). *E. macusaniensis* and *E. punoensis* were implicated as causes of coccidiosis in cases seen at the VLA. All ages of alpacas were affected and the clinical history was not always deemed typical. Cases often occurred within 1 month of a stressful event.

Similar findings in the USA were published in 2007 describing cases of coccidiosis due to *Eimeria macusaniensis* in alpacas and llamas aged between 3 weeks and 18 years old. Many severely affected camelids had signs of lethargy, weight loss, decreased appetite, and diarrhea. Postmortem examination frequently revealed complete, segmental replacement of the mucosa of the distal portion of the jejunum with coccidial meronts and gamonts. For 17 of 42 camelids, results of initial fecal examinations for *E. macusaniensis* were negative.

Cebra, C. K.; et al. Javma-Journal of the American Veterinary Medical Association. 230 (2007) 94-100.

Reported clinical signs of coccidiosis in South American camelids include anorexia of a few days duration, diarrhea or sudden death. Ante mortem diagnosis of clinical coccidiosis is usually based on clinical signs and supported by detection of coccidial oocysts in feces. This report describes 2 atypical cases of coccidiosis in South American camelids that had no coccidial oocysts detected on antemortem fecal flotation, prolonged weight loss, and normal fecal consistency.

Chigerwe, M. et al. Journal of Veterinary Diagnostic Investigation 19 (2007) 122-125.

Coccidiosis in wildlife

A paper from Iceland "Two new *Eimeria* species (Protozoa: Eimeriidae) from wild rock ptarmigans, *Lagopus muta islandorum*," reported the findings from 100 wild ptarmigans. The paper is very comprehensive with detailed morphological descriptions of both oocysts and sporocysts.

Skirnisson, K and Thorarinsdottir S T. Parasitology Research 101(2007) 1077-1081