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Turning the Worm

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Welcome to this issue of TTW. The main purpose of this informal newsletter is to share information with those particularly interested in the management of endoparasites of farmed animals, including sheep, goats and cattle.

In This Issue

Anthelmintic resistance in the UK

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Cattle

In a local survey in the south-west of England in 1988, the first case of ivermectin resistant nematodes (*Cooperia oncophora*) was found in the northern hemisphere in Somerset (1). A subsequent case was referred as a failure of chemotherapy (2). In a recent telephone survey of 75 beef farmers (unpublished|) one farmer suggested ivermectin was not effective. There is thus some anthelmintic resistance in nematodes in cattle but its true extent is not known and it is at present unlikely to be large. Since it is not usually necessary to treat adult cattle, there should be a good source of nematodes in refugia. Provided calves are not grazed on the same pasture each year and arriving cattle are quarantined on to the farm, resistance should be slow to develop and spread. It all depends on whether farmers treat adult cattle for that little extra productivity. If they do resistance will spread.

Sheep

The true extent of anthelmintic resistance is not known and will undoubtedly vary from region to region and be increasing. However, present information gives little room for complacency. In a survey conducted in the south-east of England three years ago 80% of farmers had benzimidazole resistance, 37% had levamisole resistance and 30% had benzimidazole and levamisole resistance (cited in 3). In lowland flocks in Scotland 80% had benzimidazole resistant nematodes (4). Of greater concern was the finding of benzimidazole-levamisole-ivermectin resistant *Teladorsagia circumcincta* in a sheep flock in Scotland (5). It is likely that this is only the tip of the iceberg as triple resistant *T.circumcincta* was found in Angora goats in 1996 (6). In a telephone survey in the south-west of England conducted this winter (unpublished) 1% of farmers thought levamisole had failed, 2% the macrocyclic lactones and 14% the benzimidazoles. This almost certainly underestimates the extent of resistance as only overt resistance will be noticed.

The development of resistance is complicated by the changing biology of the nematodes. *Haemonchus contortus* is spreading northwards with less seasonality and *Trichostrongylus* sp. are becoming of increasing importance. Traditionally *Nematodirus battus* was a spring disease of young lambs but *N.battus* is now being found at other times of year as well.

To address the problem of worm control in sheep a recent meeting in London made a series of recommendations.

1. Quarantine

All sheep being introduced on to a farm should be given levamisole and macrocyclic lactone. As combination drenches are not available in the UK these will have to be given sequentially. Probably moxidectin should be used as current evidence suggests that it will kill ivermectin resistant nematodes. After treatment sheep should be yarded for 48 hours before being turned out on to contaminated pasture.

2. Flock testing

To help reduce the use of anthelmintics flocks should be tested with faecal egg counts prior to treatment. The cost off egg counts should be less than mustering and dosing the flock. Anthelmintics are only a small part of the true cost of treatment.

3. Ewes

The tradition of treatment at tupping adopted by most sheep farmers should be abandoned. Similarly, if there is not a problem with *Haemonchus,* ewes will not normally be dosed at housing or turn out as this will strongly select for anthelmintic resistance. If ewes require treatment for *Haemonchus* the narrow spectrum drug closantel should be used.

4. Treat and move

Although a very effective method of nematode control, treatment with anthelmintic and immediate movement of ewes or lambs to safe grazing should cease because it is an effective method of selecting for resistance as pasture contamination is coming from those worms that survive treatment. Where possible some lambs (heaviest) should be left untreated to ensure that there are nematodes in refugia.

5. Resistance status

Faecal egg count reduction tests should be run on all farms to establish what anthelmintics are fully effective. Where resistance is found products to which there is resistance should be discontinued. Egg counts will be taken 7-10 days after treatment with a benzimidazole, 3-7 days after levamisole/pyrantel and 18-21 days after a macrocyclic lactone. In vitro tests can be used for benzimidazole (Egg Hatch Test) or levamisole (MicroAgar Larval Development Test). They are more sensitive if delineating doses rather than LD_{50} values are calculated.

6. Goats

Since anthelmintic resistant nematodes are more common in goats than sheep, goats should not be kept on sheep farms.

Liver fluke

There was also concern about liver fluke which has increased considerably in recent years, primarily it is believed due to increased rainfall at the critical time of year for the snails (April to July). However there is concern that over reliance on one product, triclabendazole, could result in widespread resistance. Failure of triclabendazole has been reported in both Scotland and Wales (7,8) but the true extent of the problem is not known due to lack of validated tests. One class of fasciolicide should not be used year after year. To avoid the introduction of resistant fluke it was recommended that animals brought on to a farm where the mud dwelling snail intermediate host, *Lymnaea truncatula,* is present should be treated with triclabendazole and closantel (or nitroxynil for cattle) and held off snail containing pastures for at least three weeks. Most fasciolicides are sold as combination products with either a benzimidazole or levamisole. For cattle clorsulon is sold with ivermectin. The use of combination products should be discouraged as this may result in unnecessary use of anthelmintics increasing the selection pressure for anthelmintic resistance.

After a long period when there has been little research or attention paid to anthelmintic resistance we are entering a new era of veterinary surgeon and farmer education and hopefully changed management practices. Only time will tell how effective the strategy will be in slowing the development and spread of anthelmintic resistant nematodes and fasciolicide resistant fluke.

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Cattle nematodes and resistance with particular reference to MLs

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Introduction

Although use of anthelmintics in cattle is widespread, the incidence of resistance has not been nearly as common or severe as in sheep nematodes. However, recently concern has been raised over the use of frequent ML treatments in north eastern NSW or south eastern Queensland. Here MLs, particularly pour-ons which have higher dose rates, are used for the control of cattle tick (*Boophilus microplus*), often at 21 or 28 day intervals. This could or may already have produced ML-resistant cattle nematodes. The following article is designed to review the current status of resistance in cattle nematodes, and highlight methods for detecting it.

Investigating Resistance in Cattle Nematodes

In the WAAVP Guidelines for Anthelmintic Resistance (Coles et al. 1992) two methods are recommended for cattle:
(a) Faecal egg count reduction test (FECRT)
(b) Egg hatch test for benzimidazoles (BZs). (This only works with nematode species where eggs hatch rapidly)

The WAAVP criterion for resistance (at least for sheep nematodes) is <95% reduction in FECRT where the lower 95% confidence interval is <90%.
There is considerable dispute on whether to use arithmetic or geometric means for calculation of effectiveness.

(a) Use of FECRT

The guidelines recommend the use of groups of 10 cattle .These need not be calves provided counts are >150 worm eggs per gram of faeces (epg).

At the time of the report there had been only two Australasian reports of resistance in nematodes from cattle in the field that had been confirmed by dose and slaughter trials. Both were against benzimidazoles. The first was *Trichostrongylus axei* in cattle in Victoria with oxfendazole resistance (Eagleson and Bowie 1986). The second, also benzimidazole (oxfendazole) resistant *Cooperia oncophora*, was in cattle in New Zealand (Jackson et al. 1987).

Coles et al (1992) warned that "Until further strains of resistant nematodes are isolated from cattle it is unwise to conclude that a failure to produce a less than 90% reduction in egg counts is associated with anthelmintic resistance."

Note the use of 90% reduction as a criteria seems to be at variance with the criteria of <95% used elsewhere in the same guidelines It may relate to the usual lower efficiencies of benzimidazole drenches in cattle compared to sheep.

(b) Use of Egg Hatch Assay

The egg hatch assay "has not been adequately evaluated with nematodes of cattle"

(c) Other Methods

Since the WAAVP guidelines were published larval development assays (LDA) have been used by a few researchers with cattle nematodes (see below). However, I am unaware of the use of the DrenchRite™ for this purpose in Australia.

Effects of Persistence of Drench on Detecting Resistance

Drenches have different durations of activity against different worm species. In cattle, *Cooperia* is the genus known as the dose-dependent species, which is least affected by drenches, and usually this is represented by a shorter period for which a drench is active. This may be related to the position of the worms in the gastrointestinal tract or the prepatent period of the species.

Some drenches may suppress egg output by female worms without killing them (this is particularly true of thiabendazole (BZ), but has also been reported for ivermectin in sheep.

Calculating FECRT only 7 days after treatment is therefore problematic and hence the recommendation that FECRTs normally be conducted 10-14 days after treatment.

Vermunt et al. (1996) suggested that "faecal sampling at 7-10 days after treatment may produce misleading results and over estimate the efficacy of an anthelmintic tested. It may therefore be better to delay the post-treatment faecal sampling until closer to the minimum prepatent period **plus** [my emphasis] the period claimed for the persistent activity, and even then, cases of resistance may still be missed."

However, if too long a period is used, for example 21 days, it is possible that egg counts are due to the intake of L3 from pasture and their development in the intervening period.

Some species such as *Cooperia oncophora* have a prepatent period of only 17-22 or 11-14 days depending on various authors.

However, if the anthelmintic is persistent, such as moxidectin, then normally no worms (or less than 98%) will develop for at least the protection period. Note the claim for persistence required by the Australian Pesticides and Veterinary Medicines Authority (APVMA, formerly NRA) guideline no.52is more stringent (>99% effectiveness for sheep and goats, >95% for cattle) than for normal efficacy (95%)

Readers should be aware that in sheep nematodes, anthelmintic resistance is frequently first detected as "emerging" when the persistent effect is reduced. This was the case with *Haemonchus contortus* resistant to one third recommended dose rate (RDR) closantel on the New England Tablelands (S.Love, personal communication), and by the use of half or quarter RDR of ivermectin to detect emerging resistance in FECRTs for *Teladorsagia (Ostertagia) circumcincta* resistant to ivermectin in Western Australia and more recently in Southern NSW. Similar loss of persistent activity could be expected as the first signs of emerging ML resistance in cattle nematodes.

The reason is probably due to the "over kill" level of the active in commercial drench being set at the level needed to kill >95% of the least susceptible species (eg *Cooperia*)

It should also be noted that neither the FECRT nor the egg hatch tests (EHT) are reliable in detecting resistance, if the proportion of resistant worms is less than 25% (Martin et al. 1989)

Duration of activity (i.e. persistence against incoming L3 larvae) was demonstrated more accurately by parasite counts than by faecal egg counts (Eddi et al. 1997).

Similarly, Vercruysse and Rew (2002) only considered persistence when the published data were given for worm counts and there was at least 90% reduction using geometric mean (according to WAAVP/ VICH (International Cooperation on Harmonisation of Technical Requirements for Registration of Veterinary Medical Products) guidelines which are less rigorous than Australia's APVMA).

ML Resistance in Australia

There have been no cases of ML resistance reported in cattle nematodes in Australia to date.

The only two confirmed cases of resistance to any anthelmintic family, which were subject to detailed kill 'um and count 'um experimental infections, were to oxfendazole in *Trichostrongylus axei* in western Victorian cattle (Eagleson and Bowie 1986), and to oxfendazole and febantel, also in *T axei* in the New England region of NSW (Eagleson et al. 1992)

ML Resistance in Europe

The only reported studies have been by Coles and co-workers (Stafford and Coles 1999, Coles et al. 2001). In the first study resistance to ivermectin only in *Cooperia* was detected in dairy farms in SW England. This was after a survey followed up with EHT and the micro-agar larval development tests (MALDT). Larvae were found which survived at >0.1 mg/mL ivermectin (IVM). Further, IVM at RDR failed to eliminate FECs at 3, 7, 14 and 21 days post treatment. A controlled trial was then conducted. Experimental infections of 8 calves each with 15 200 L3 were done. Groups were treated at day 28 post-infection (PI) with 200μg/kg ivermectin injected subcutaneously. These animals were then killed on day 7 post-treatment (PT) (= day 35 PI). Arithmetic mean EPG and TWC on day 35 were compared. The main findings were: a) Only *Cooperia* were detected
b) egg counts were reduced from 425 to 238 epg (44% efficacy = 56% FECRT) on Day 7 PT but c) total worm counts were only reduced from 3730 to 3140 (16% efficacy = 84% remaining).

It was concluded that *Cooperia* was resistant. This is not surprising since this species is dose limiting. Also, although ivermectin reduced egg count seven days after treatment, it "had no effect on the worm burden". They also concluded, based on other unpublished observations, that "elimination of egg counts, that is less than 50 epg [which was their sensitivity of the test], 14 days after treatment can not be used to indicate freedom from ivermectin-resistant nematodes"

ML Resistance in New Zealand

Studies by Vermunt et al (1995, 1996) followed up earlier discoveries of BZ resistance in *Cooperia* in cattle in the late 1980s and early 90s. Ivermectin-resistant *C. oncophora*, with possible side-resistance to topical moxidectin (MOX) as judged by FECRT 19 days after MOX treatment was detected in 6 of 17 calves. It is possible that reinfection was responsible for egg counts but they concluded it was more likely due to temporary suppression of egg production (Vermunt et al. 1995).

In the second study, egg count reductions were done 7, 14 and 21 days after injectable IVM and MOX indicated resistance to both compounds, and although doramectin (DOR) (injectable) had a temporary suppression of counts, by day 21 PT of the IVM-resistant worms, it was deemed not to be effective. As the calves were not removed from possible re-infection from pasture and slaughter worm counts were not conducted, there is the possibility that these egg counts are from suppressed worms or maturation of resistant larval stages.

ML Resistance in South America

MLs have been used frequently in cattle in South America. Eddi et al. (2002) found that "there are only two reports of reduced efficacy and MLs in cattle." These studies used the FECRT and evaluated efficacy. IVM and DOR showed 75% efficacy in epg reduction, while MOX showed 90% efficacy in cattle having *Cooperia* spp, (Anziani et al. 2000). The other study showed resistance in *Cooperia* spp and *Trichostrongylus* spp, to IVM and DOR, which had 65% and 85% efficacy respectively, while fenbendazole and MOX produced epg reductions of 100 and 95% respectively (Fiel et al. 2000).

Conclusions

Although evidence of resistance in cattle worms is only slowly coming to light, and has so far been restricted to the less pathogenic species of *T. axei* and *Cooperia*, it should be expected that resistance to MLs is likely to become established in Australia. Once cases of resistance in *Ostertagia ostertagi* (or to *Haemonchus placei* in more tropical zones) appear you can be sure that there will be considerable interest aroused in both the veterinary chemical industry and amongst cattle producers. Unfortunately, there may be few veterinary parasitologists left who will be able to do much about it.

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Macrocyclic lactone resistance in Australian sheep nematodes[1]

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Introduction

Because of the widespread prevalence of anthelmintic resistance in nematodes of small ruminants around the world (Waller, 1997; Jackson & Coop, 2000), the macrocyclic lactone (ML) class of anthelmintics occupies a position of special importance. The prevalence of nematode parasites of sheep and goats resistant to the older benzimidazole (BZ) and levamisole (LEV) families of anthelmintics means that the MLs are now the most commonly used group. For example, MLs now account for well over half of the number of total doses of broad-spectrum anthelmintics sold for use in sheep in Australia, despite being more expensive than the BZ, LEV and BZ/LEV combinations. It is reasonable to assume that this proportion would be even greater if more farmers were aware of resistance levels in worms on their own farms. Escalating reliance on MLs for worm control places these compounds under increasing pressure from resistant worms. Resistance to BZ and LEV is almost universal on sheep farms in South Africa, Australia and many South American countries. MLs are thus

[1] This article originally appeared in the Summer 2002/2003 issue of "Skirting the Issues" –Newsletter of the Australian Sheep Veterinary Society – and is reproduced with permission.

the only chemical group that can be used reasonably confidently by most farmers in these countries without specific knowledge of the resistance status of worms on their own farms.

In Europe and North America, anthelmintic resistance is largely confined to the benzimidazole and levamisole families. Resistance against the MLs is relatively rare and typically confined to worms in goats. In some southern hemisphere countries, however, ML resistance is common enough to show up in random surveys. ML resistance was at a low level in Uruguay in 1996 (1.2% of farms, Nari et al., 1996), but present on 6% of farms in Argentina (Eddi et al., 1996, 13% in Brazil (Echevarria et al., 1996) and on some 70% of sheep farms in Paraguay (Maciel et al., 1996). The resistance situation in South Africa is even worse, with *Haemonchus* resistant to BZ on 79% of farms in summer-rainfall areas, to MLs on 73% of farms and to LEV on 23% of farms (van Wyk et al., 1999).

Prevalence of ML resistance in Australia

The only national random survey of anthelmintic resistance was conducted in 1991-1992, when only 9% of farms had no recorded resistance to any anthelmintic (Overend et al., 1994). BZ resistance was present on 85% of farms; LEV resistance was detected on 65% and 60% had resistance to a combination of these two groups. No ML resistance was recorded at this time, which was an expected result only 2 or 3 years after the release of ivermectin, the first of the MLs for sheep on the Australian market. At around the same time, the first isolated cases of avermectin resistance in both *Haemonchus contortus* (Le Jambre, 1993) and *Ostertagia circumcincta* (Swan et al., 1994) were recorded. ML resistance has since evolved rapidly, with cases of resistance now being commonly reported in both *Haemonchus* and *Ostertagia*. This rapid evolution was also expected, given that ML resistance in the field in these genera appears to be conferred by a single dominant gene (Dobson et al., 1996; Barnes et al., 2001; Sutherland et al., 2002) under treatment with ivermectin.

The best information about the current prevalence of ML resistance in Australia comes from Western Australia where 38% of 139 farms sampled had detectable (with a half-dose of avermectin) ML resistance in *Ostertagia circumcincta* (Palmer et al., 2000). This was not a strictly random sample of sheep farms, but was derived from a state-wide bi-annual worm egg-counting quality assurance program where participating veterinarians included a half-dose of avermectin in routine faecal egg count reduction tests (FECRT). Even by the more traditional diagnostic criterion of resistance as a less than 95% reduction in faecal egg counts following treatment with a full dose of anthelmintic, 19% of the 139 farms sampled would have been considered to be harbouring ML resistant *Ostertagia*. Palmer et al. (2000) present a compelling argument for the view that a reduction of 95% or less in faecal egg count following treatment with any ML at half dose rate is clear evidence of resistance.

From routine FECRTs conducted on 18 farms on Kangaroo Island in 2000, Rendell and Lehmann (2001) found that 80% had *Ostertagia* resistant to ivermectin at full dose rate, or 95% of 19 farms when diagnosed at half dose rate. In western Victoria in the same year, the prevalence of ML resistance by the same criteria was somewhat lower at 0% (of 20 farms) or 25% (of 24 farms) respectively. Larsen and Anderson (pers. comm.) reported the prevalence of ML resistance in western Victoria in 1999-2001 as 6% of 36 farms when tested at full dose rate and 20% of 15 farms at half dose rate.

The situation in the summer-rainfall regions of Australia where *Haemonchus contortus* is endemic is equally disturbing. Ward et al. (2000) found ML resistance in this species using a full dose of ivermectin on 10% of 62 selected farms in south-east Queensland, using faecal egg count reduction tests. Using client-initiated FECRTs in northern NSW, E.B. Hall (pers. comm.) found that in 17% of 30 cases, a full dose of ivermectin failed to reduce egg counts by more than 95%, and in 62% of 13 cases, a half dose of ivermectin was not fully effective. B.F. Chick (pers. comm.), has recorded that 71% of 70 mobs of sheep in northern NSW treated with the ivermectin controlled-release capsule had positive *Haemonchus* egg counts (range 4 – 1832 epg) within 121 days of administration. Chick also states that around 40% of recent FECRTs indicate the presence of ML resistant *Haemonchus*.

Although none of this evidence would satisfy the statistical purist, being largely based on self-selected samples of farms whose owners may be more concerned with worm control than would the average sheep producer, it does suggest that ML resistance may be detectable in *Ostertagia* on 40% to 95% of farms in the more pronounced Mediterranean climatic regions of Western Australia and Kangaroo Island, and at a lower prevalence, perhaps 20%, in Victoria and possibly southern NSW. For ML-resistant *Haemonchus*, the observed prevalence in northern NSW appears to be similar to that of ML resistance in *Ostertagia* in Western Australia, and on perhaps 10% of Queensland sheep properties.

Severity of ML resistance

Information on the severity of ML resistance, as measured by the percentage reduction in either faecal egg count or worm count following treatment, is rarely reported for substantial numbers of farms in any region, let alone on the hundreds of randomly selected farms across Australia that would be required to draw firm conclusions about the current or typical severity of ML resistance in this country. Since resistance is technically defined as a reduction of 95% or less in egg count or worm burden following treatment (Anon, 1989) the prevalence data above imply an upper limit on the efficacy of ivermectin, as the least potent ML, of 95% against *Ostertagia* on around 20% of sheep farms in Western Australia and against *Haemonchus* on a similar proportion of farms in northern NSW and south-east Queensland. There are also localised areas, such as Kangaroo Island, where the prevalence data imply a similar upper limit of efficacy on nearly all farms; this compares with an observed average efficacy across 18 farms on the island of 91% with ivermectin at the recommended dose rate and 81% at half dose rate (Rendell and Lehmann, 2001). Reported efficacies of MLs against resistant worms on individual farms are much lower as might be expected. Woodgate et al. (2001) describe a strain of *O. circumcincta* where the efficacies of ivermectin, abamectin and moxidectin were 74%, 95% and 99% respectively by FECRT, and another where egg count reductions for the same three drugs were

Anthelmintic resistance in NSW – more in the next issue

More information on anthelmintic resistance in NSW will be published in the next issue of Turning the Worm. Sources will include:

- Dr Gareth Hutchinson, NSW Agriculture, who presented a review of the NSW situation at the annual meeting of the Australian Society for Parasitology, Hobart, October 2002.
- Drs Bruce Chick and Michelle Wooster, Veterinary Health Research, Armidale.

-SL.

85%, 100% and 100%. Efficacies against the latter strain were also estimated concurrently using total worm counts, and it was found that worm count efficacies were much lower than those suggested by egg count reductions; ivermectin reduced worm counts by only 54%, abamectin by 89% and moxidectin by 97%, suggesting that FECRTs may underestimate the severity of resistance, at least in *Ostertagia*.

The severity of ML resistance in Australian *Haemonchus* appears to be even greater than that seen in *Ostertagia*. Le Jambre et al. (1995) isolated a strain in northern NSW in which twice the recommended dose of ivermectin removed 16% of the worms, while the recommended dose of moxidectin removed 96%. Ivermectin, abamectin and moxidectin showed efficacies against a resistant field strain from the same region of 54%, 74% and 100% respectively, although moxidectin showed greatly reduced efficacy against larvae acquired following treatment (Wooster et al., 2001). This relative failure of moxidectin to prevent establishment of ML resistant worms after treatment, while simultaneously showing high efficacy against susceptible worms is probably a general phenomenon, as it has also been observed with ML resistant *Ostertagia* (Rolfe & Fitzgibbon, 1996; Sutherland et al., 1997) and has been independently confirmed for resistant *Haemonchus* (Barnes et al., 2001). It seems also to be a general phenomenon that moxidectin shows superior efficacy against resident worms of ML-resistant strains in comparison with the avermectins. This was first noted by Kieran (1994), and has been confirmed with both *Haemonchus* (Barnes et al., 2001) and *Ostertagia* (Leathwick et al., 2001; Sutherland et al., 2002). This is attributed to the greater potency of moxidectin.

The most highly ML-resistant strain of *Haemonchus* reported so far in Australia, if not the world, appears to be that described by Love et al. (2002), also from a farm in northern NSW. Ivermectin showed 0% efficacy, abamectin 19% and moxidectin 84% on one occasion and 67% on another some 3 months later. All of these efficacies were estimated by FECRT at the recommended dose rate, and this strain was also resistant to levamisole and closantel. The farm had a long documented history of *Haemonchus* resistant to levamisole, closantel and albendazole, although they remain susceptible to naphthalophos.

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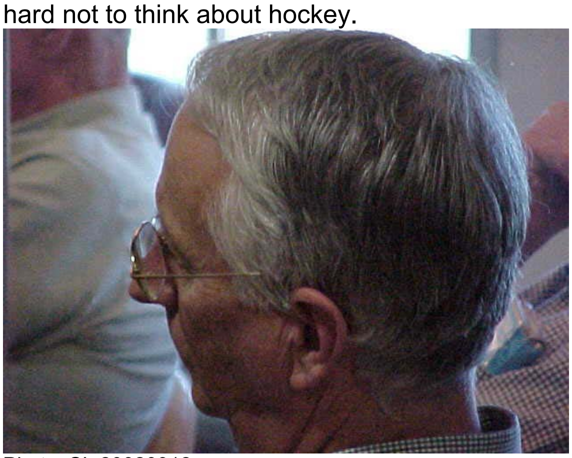
Dr Bob – Grandmaster

And now for our human interest story:

Dr Bob Coverdale, Senior Field Veterinary Officer with NSW Agriculture at Dubbo, is representing Australia in **hockey** (again?). Bob is in the **Australian GrandMasters** (65 yo and over –surely he is not old enough?!) and will be overseas soon representing our country. CSIRO scientist **Dr Keith Ellis** is another hockey star and also a good mate of Bob's. Being a mere youngster, **Keith is playing for Australia in the Masters.**

All the best, Bob and Keith! Well done!

Bob Coverdale in a Fletcher International/NSW Agriculture seminar at Lightning Ridge – and trying hard not to think about hockey.



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'New' drenches –

- **NoDrench™**
  (Plant Industries)
- **Chlorophyll ™**
  (Marchant Inc)

These may not be new products, but for some they could well be novel.

An American correspondent told me about an inquiry fielded on an international discussion list by well-know Australian sheep vet, Dr John Plant (formerly of NSW Agriculture).

"What is the best drench for sheep tapeworm?'' someone asked.

"**No Drench!"** replied John Plant. This answer was followed up by (serious!) questions as to where one could buy this product.

Bob Marchant, Sheep and Wool Officer with NSW Agriculture at Armidale NSW says that **'Chlorophyll'** is often a great 'drench'. Putting sheep onto a fresh, green paddock, especially if it is a 'low-worm' paddock, often does wonders in reducing worm burdens. (Bob kept quiet about this in the drought).

For best results, both should be used in conjunction with that other under-utilised product, **WormTest**.