Gastro-intestinal parasitism and "anthelmintic resistance" in goats

Parasitism, particularly that resulting from gastro-intestinal nematode burdens, is a very significant production-limiting disease in New Zealand goats. From 1974 to 1980 it accounted for 45% of all positive diagnoses on goat samples received at Animal Health Laboratories in this country[13].

The nematode genera infecting goats are the same as those infecting sheep, although there may be some differences in the precise species involved. In the small intestine, for example, infections with *Trichostrongylus* are common to both. However, in sheep, such infections usually consist of a mixture of 2 main species, *T. colubriformis* and *T. vitrinus*[5], whereas in goats, *T. capricola* frequently predominates[1].

Largely because of the similarity of their parasite burdens, gastro-intestinal parasitism in sheep and goats is often discussed under the same general heading in textbooks. However, it is becoming increasingly apparent that there are major differences between sheep and goats, both in terms of their susceptibilities to nematode burdens and in their reactions to the drenches used to control them. These can be briefly summarised as follows:

- Significant worm burdens may be acquired at a much earlier age in goats than in sheep. At the Palmerston North AHL, for instance, faecal egg counts of between 1100 and 4000 e.p.g., and total worm burdens of over 17 000 have been recorded in kids as young as 3 to 4 weeks of age.
- Age-related resistance appears to be much slower to develop in goats than in sheep. Thus, unlike sheep, goats apparently do not develop an appreciable resistance to the establishment of worm burdens with increasing age and with experience of infection[4 9 10], although there is some evidence to suggest that older animals may be better able to withstand their effects[4].
- Faecal egg output may be up to 4 times greater in goats than in sheep with comparable worm burdens[13].
- Many anthelmintics appear to be less effective in removing worms from goats than they do from sheep.

The recommended dose rates for anthelmintics for use in goats are the same as those for use in sheep. However, in a recent survey[9], evidence of a substantial degree of anthelmintic ineffectiveness was found in almost 80% of 47 milking goat herds in New Zealand. In contrast, a comparable lack of anthelmintic effectiveness was found in only 2 of 90 sheep farms surveyed[7 8].

Anthelmintic ineffectiveness in goats has been recorded not only for benzimidazole drenches but also for the other main broad spectrum drench group – the cell membrane depolarisors, levamisole and morantel. The cause of this ineffectiveness is not entirely clear but appears to be associated with either:

- Differences in the pharmacokinetic behaviour of drenches in sheep and goats.
- The widespread occurrence of drench-resistant worm genotypes in goats.
- A combination of the above.

The following points suggest that drench failure in goats may be primarily associated with the host rather than with the worm "strains" it contains:

- The occurrence of the problem is widespread. It is difficult to believe that 80% of milking goat herds in this country contain resistant worm populations, particularly when such populations in sheep have been recorded only relatively infrequently. Nematodes in goats are transmissable to sheep, and therefore, it might reasonably be expected that a high frequency of resistant worm genotypes in 1 host would be reflected by a similar prevalence in the other. It is recognised, however, that any disparities in this regard may merely be related to the lack of contact between goat herds and sheep flocks.
- In goats, anthelmintics attain much lower plasma levels than they do in sheep and are eliminated much more rapidly[2 9]. Since the efficacy of benzimidazole anthelmintics (at the least) may be correlated with the length of time that the drug remains in the plasma above a certain concentration[12], drench failure in goats could simply be related to the fact that currently recommended dose rates are inappropriate for this host. Support for this view may be provided by the fact that some anthelmintics, highly effective against "strains" of *Ostertagia* and *Trichostrongylus* in sheep, have been found to be less effective, at the same dose rate, against these same "strains" in goats[3].
- Individual goat herds often contain several genera of worms, all showing apparent "anthelmintic resistance" and frequently to more than 1 drench type[9]. By contrast anthelmintic resistance in sheep has normally been found to be monospecific – i.e. only 1

genus of worm on a particular property has been found to be resistant to a particular drench.
- Although levamisole and morantel belong to a family of drenches with the same action (cell membrane depolarisers), they differ in their spectrum of activity when applied to milking goats[9]. This is in contrast to the situation in sheep where nematode populations resistant to 1 member of an action family of drenches are usually resistant to other members of that group as well[11].

On the other hand, the suggestion that drench failure in goats may be associated with "truly" anthelmintic-resistant worm populations is supported by the fact that:

- Some "strains" of goat nematodes have been shown to be resistant to anthelmintics when divorced from the host – for instance, by means of *in vitro* egg hatch assays[9].
- Some strains of "resistant" nematodes recovered from goats have retained their resistant status when transmitted to sheep[6 9].
- Anthelmintics can perform well in goats against some field strains of worms found in sheep[9].

The contradictory and confusing information cited above makes it apparent that the primary cause of anthelmintic ineffectiveness in New Zealand goats is still largely uncertain. However, while it is evident that there may well be some goat nematode populations exhibiting "true" anthelmintic resistance, it also seems feasible that a substantial proportion of such "resistant" cases are more likely to be due to suboptimal drenching brought about by the peculiarities of the goats' metabolism and by failure to administer drenches at the appropriate dose rate, particularly in animals at the higher end of the weight scale[9].

In the case of a number of anthelmintics, precisely what constitutes an appropriate dose rate varies according to the host to be treated. The following are the recommended dose rates, for sheep and cattle respectively, for these anthelmintics: thiophonate – 50 and 75mg/kg, fenbendazole – 5 and 7.5mg/kg, thiabendazole – 44 and 88mg/kg, and albendazole – 3.8 and 7.5mg/kg. The recommended dose rates for anthelmintic usage in goats are the same as those for use in sheep. Unfortunately such recommendations appear to be based on little or no hard data, apart from a general assumption that what is highly efficacious in sheep should be equally efficacious in goats.

Because of this, and because anthelmintic resistance may be defined as the heritable ability of some individuals within a parasite population to survive doses of an anthelmintic which *would ordinarily prove lethal* to them, one could question the validity of using the term "anthelmintic resistant" in respect of goat nematode populations at all.

Whatever terminology is adopted, however, and whatever the underlying causes of such drenching failure, it is obvious that the control of gastro-intestinal parasitism represents a major problem for many goat farmers. It is also obvious that, in attempting to overcome this problem, a number of farmers are resorting to very frequent drenching (in some cases, up to 34 times a year[9]). Such a procedure must surely lead to the development of "true anthelmintic resistance", if it has not done so already. Furthermore, because natural resistance to infection with age is absent in goats, because of their high faecal egg output, and because of the fact that sheep and goats share the same nematode genera, such practices may pose a potentially serious threat to the sheep industry as well.

There is, therefore, obviously some need to clearly establish effective anthelmintic dose rates for goats. In the meanwhile I would like to make 2 suggestions: firstly, that the use of anthelmintics at greater than their currently "recommended" dose rates may be preferable to increasing the frequency of drenching; and secondly, that until the underlying cause(s) are precisely identified, cases of drench failure in goats be referred to as examples of "anthelmintic ineffectiveness" rather than "anthelmintic resistance".

[1] *Agricultural Research Division Annual Report* 1979/80: 256.
[2] *Agricultural Research Division Annual Report* 1981/82: 168.
[3] *Agricultural Research Division Annual Report* 1982/83: 202.
[4] *Agricultural Research Division Annual Report* 1982/83: 204.
[5] Brunsdon, R.V. (1970): Seasonal changes in the level and composition of nematode worm burdens in young sheep. *NZ Journal of Agricultural Research*, 13: 126-148.
[6] Hall, C.A.; Ritchie, L.; McDonell, P.A. (1981): Investigations for anthelmintic resistance in gastrointestinal nematodes from goats. *Research in Veterinary Science*, 31: 116-119.
[7] Kettle, P.R.; Vlassoff, A.; Ayling, J.M.; McMurtry, L.W.; Smith, S.J.; Watson, A.J. (1982): A survey of nematode control mea-

sures used by sheep farmers and of anthelmintic resistance on their farms. Part 2. South Island excluding the Nelson region. *New Zealand Veterinary Journal*, 30: 79-81.

[8] Kettle, P.R.; Vlassoff, A.; Lukies, J.M.; Ayling, J.M.; McMurtry, L.W. (1981): A survey of nematode control measures used by sheep farmers and of anthelmintic resistance on their farms. Part 1. North Island and the Nelson region of the South Island. *New Zealand Veterinary Journal*, 29: 81-83.

[9] Kettle, P.R.; Vlassoff, A.; Reid, T.C.; Horton, C.T. (1983): A survey of nematode control measures used by milking goat farmers and of anthelmintic resistance on their farms. *New Zealand Veterinary Journal*, 31: 139-143.

[10] Le Jambre, L.F.; Royal, W.M. (1976): A comparison of worm burdens in grazing merino sheep and angora goats. *Australian Veterinary Journal*, 52: 181-183.

[11] Prichard, R.K.; Hall, C.A.; Kelly, J.D.; Martin, C.A.; Donald, A.D. (1980): The problem of anthelmintic resistance in nematodes. *Australian Veterinary Journal*, 56: 239-250.

[12] Prichard, R.K.; Kennessy, D.R. (1981): Effect of oesophageal groove closure on the pharmacokinetic behaviour and efficacy of oxfendazole in sheep. *Research in Veterinary Science*, 30: 22-27.

[13] *Surveillance*, 1982 Vol. 9 No. 3: 18.

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