CROSS TRANSMISSION OF BOVINE PARASITES TO SHEEP*

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SINCE 1960, an investigation of parasitism on community pastures in the Maritime provinces of Canada has been conducted by the authors. On several pastures, both cattle and sheep are grazed and to minimize residual pasture infections, the sheep and cattle pastures are alternated each grazing season. Another practice occasionally followed, is that of grazing cattle behind the sheep in order to make maximum use of available pastures. This practice is dependent upon the pasture growth.

During these investigations, more than 140 ovine gastro-intestinal tracts have been examined for parasites. In many specimens, especially those examined early in the grazing season, the cattle parasite *Cooperia oncophora* was present, occasionally in numbers up to 4,000–5,000 (10).

Several workers (3, 4, 7, 8, 12), studying cross transmission of parasites between cattle and sheep, have shown that a considerable degree of host specificity is present, although many parasites from one host may establish in another. Stoll (12) demonstrated that *Haemonchus contortus, Trichostrongylus axei, Cooperia curticei, Capillaria longipes, Trichuris ovis, Nematodirus helvetianus* and *Gongylonema scutatum* were picked up by parasite-free lambs from cattle while *Cooperia oncophora* and *Cooperia punctata* apparently did not establish in sheep.

Porter (8) reported that calves grazing on pastures contaminated by cattle acquired appreciably more *Haemonchus* than did lambs grazing on the same pasture. On pastures contaminated by sheep the opposite was true. *Cooperia punctata* and *Cooperia pectinata* developed in numbers 9–30 and 2–30 times greater, respectively, in calves than in lambs, whereas *Cooperia curticei* from sheep developed approximately as well in calves as in sheep. *Trichostrongylus colubriformis* was not transmitted to calves by exposure to these parasites from sheep and *Strongyloides papillosus* was poorly transmitted. The cattle parasites, *Oesophagostomum radiatum, Nematodirus helvetianus* and *Ostertagia ostertagi* were not transmitted to lambs while the sheep parasites *Oesophagostomum columbianum* and *Bunostomum trigonocephalum* were not transmitted to calves.

The trial reported in this paper was undertaken in 1963 to investigate the cross-transmission of *Cooperia oncophora* and other bovine parasites, common in Maritime cattle, to sheep and the role, if any, that cattle might play in perpetuation of parasitic infections in sheep, particularly on the community pastures.

MATERIALS AND METHODS

Seven parasite-free Shropshire lambs, born between March 15 and 22, 1963, were obtained for this trial. The lambs were reared under the parasite-free conditions described earlier (11). On June 13, all lambs were placed on a known parasite-free pasture and on June 21, five of the lambs, chosen at random, were placed in a small paddock, 7125 sq. ft. in area which was situated within an infected marsh pasture on which only cattle had grazed for 14 consecutive seasons. During the 1962 season, calves heavily parasitized with *Ostertagia ostertagi, Cooperia oncophora, Nematodirus helvetianus* and smaller numbers of *Oesophagostomum radiatum, Trichuris ovis, Chabertia ovinus, Moniezia benedeni* and *Capillaria sp.* had remained on the pasture until September 24. The pasture had remained vacant from September 24, 1962, until the lambs were placed there on June 21, 1963. On the same date, parasite-free calves were placed on the remainder of the infected pasture. The two control lambs and one parasite-free calf

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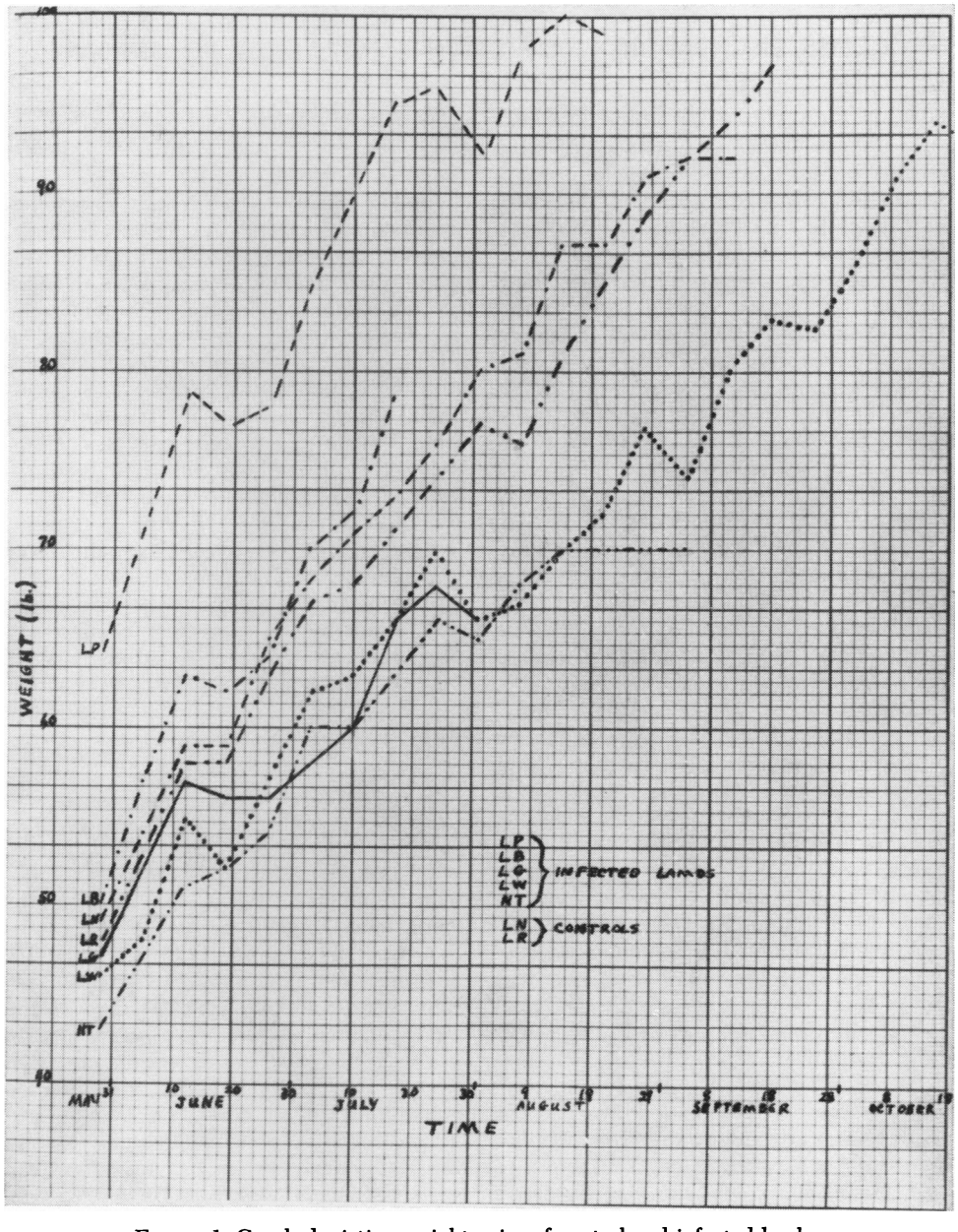

FIGURE 1. Graph depicting weight gains of control and infected lambs.

were kept in a parasite-free paddock measuring 100 × 200 feet. The lambs were weighed weekly from May 29 until the termination of the trial. On all lambs, fecal examinations were carried out prior to, and during, the grazing season at biweekly and weekly intervals, respectively. Feces from the exposed lambs were also checked daily during a three-week period, which began 14 days after being placed on the infected pasture. Fecal samples of 3–5 grams were examined by a simple flotation method, using super-saturated sodium nitrate as the flotation solution and *all* ova observed were counted. The infected lambs were killed, one at a

time, at two–three week intervals beginning approximately one month after exposure to the infected pasture, except for the last animal which remained on the pasture until the end of the grazing season. The control lambs were slaughtered towards the end of the trial. At necropsy, the gastro-intestinal tracts were examined for parasites, using Swales method (13). The washed digestive tracts were then held at −8° C. and were later digested and examined for immature parasites by the technique outlined by Parnell (6).

Observations and Results

Clinical symptoms of disease did not develop in the lambs exposed to the heavily contaminated pasture. Throughout the trial all lambs remained alert and active and the feces were pelleted and normal in appearance.

Weight gains for both infected and control lambs are shown in Figure 1. The gains recorded for those lambs remaining more than a month on the infected pasture were not as uniform or as rapid as those of the controls.

Results of the fecal examinations indicated that ova production was almost negligible as the greatest number of ova recorded for one flotation was seven. Positive flotations were obtained for all lambs exposed to the infected pasture and the greatest number of positive flotations for any animal was six. With one exception, all positive flotations occurred two to six weeks after exposure to the infected pasture.

At necropsy, no gross pathological lesions were observed except for the presence of small, whitish papules or foci on the abomasal mucosa of the lambs on the infected pasture. Histologically, mild degeneration of the columnar surface epithelium in these areas was evident, with a few mononuclear cells superimposed. Mononuclear cells (predominantly lymphocytes) were evident within the gastric pits and had infiltrated into the lamina propria and the vicinity of the muscularis mucosa. The muscularis mucosa was fibrous and thickened, inflammatory cell infiltration was prominent and numerous eosinophils were present. No parasites were observed. The controls did not have such lesions.

The results of the parasitological examinations are given in Table I. *Cooperia oncophora*, *Trichuris ovis* and *Moniezia benedeni* were the only species to establish in the lambs. It is interesting to note that only adult *Cooperia* were recovered and in considerably reduced numbers after two months' exposure to the infected pasture. The one lamb kept until late in the grazing season apparently had shed its parasites.

The *C. oncophora* recovered from the lambs were appreciably smaller than those recovered from infected calves on the same pasture (Figure 2). Furthermore, fewer ova were observed within the female *C. oncophora* from lambs as compared to those observed in calves.

TABLE I

Summary of Numbers and Species of Parasites Found in Lambs Exposed to a Pasture Contaminated with Bovine Parasites

Lamb	Days Exposed to Infected Pasture	*Cooperia oncophora*	*Trichuris ovis*	*Moniezia benedeni*	Comments
LB	28	3000	0	0	Approximately 50% immature
LG	42	5960	0	0	Approximately 75% immature
LP	62	170	5	0	Only adult *Cooperia*
NT	84	1370	3	2	Only adult *Cooperia*
LW	136	0	1	0	
LN (Control)	0	0	0	0	
LR (Control)	0	0	0	0	

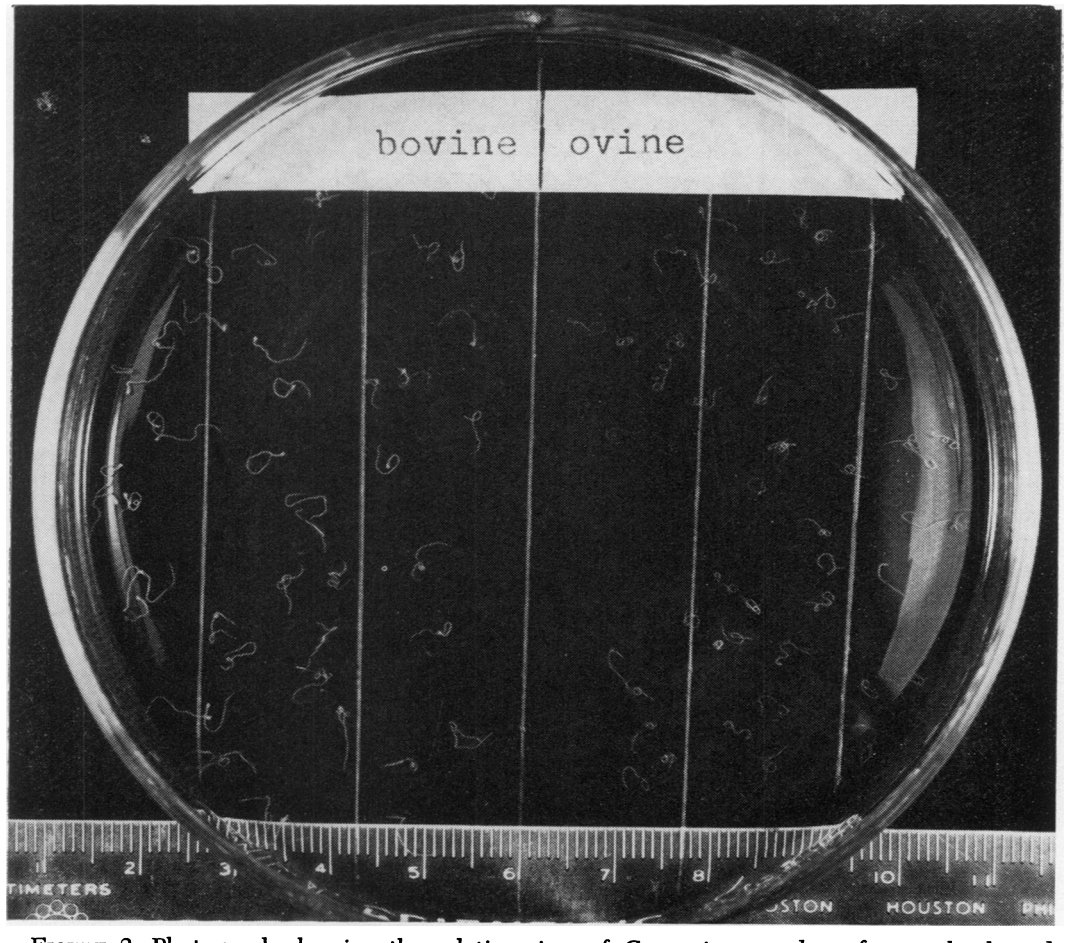

FIGURE 2. Photograph showing the relative sizes of *Cooperia oncophora* from a lamb and a calf killed 28 and 29 days, respectively, after exposure to infected pasture. Twenty-five specimens of each sex were chosen at random from each host.

Digestion studies of the gastro-intestinal tracts of the exposed lambs failed to reveal immature histotropic parasites, while such forms were recovered from calves on the same infected pasture. Neither adult nor immature parasites were recovered from control lambs or calf.

DISCUSSION

The results obtained in this limited trial support the conclusions reached by various other workers that the parasites found in ruminants have considerable host specificity (1, 2, 3, 4, 7, 8, 9) which is more marked for some species. Of the eight species of parasites known to be present in the cattle that used the pasture prior to the lambs, only three species, *Cooperia oncophora*, *Trichuris ovis* and *Moniezia benedeni* were recovered in the lambs. All but *Oesophagostomum radiatum* were recovered from calves on the same pasture during the same period, indicating that seven of the species, at least, survived over winter (10). The failure of *O. ostertagi* and *N. helvetianus* to establish in lambs, even though they were two of the three prevalent bovine species present, is consistent with Porter's findings (8). While Stoll (12) reports the presence of *N. helvetianus* in lambs, the identification of his specimens was not certain.

The numbers of *C. oncophora* recovered from the lambs are consistent with those previously mentioned for lambs on the

community pastures, but they fall far short of the numbers found in calves. The average number of *C. oncophora* found in six non-treated calves examined from the same pasture between July 7 and September 4 was over 32,000 (10). The numbers of *C. oncophora* in the lambs and calves in this trial agree closely with the results Porter obtained for *C. punctata* and *C. pectinata* in these species. Stoll (12) did not establish *C. oncophora* and *C. punctata* in sheep in his work. If, as the results of this limited trial suggest, a fairly rapid build-up of resistance and a throw-off of the parasitic load occurs for bovine *Cooperia* in sheep, Stoll's failure to find these species in sheep might be explained by the fact that his animals had remained on the infected pasture for many months prior to examination.

Although *O. ostertagi* were not established in the lambs nor were immature stages found upon digestion or histopathological examination, the lesions found in the abomasal mucosa are suggestive of parasitic migration. They are similar to the lesions found in the calves on the same pasture where *O. ostertagi* infections were established. Furthermore, no other abomasal parasite was present in either calves or lambs, which could account for the lesions. Also no abomasal lesions were observed in parasite-free lambs and calves. It would appear that the host specificity of *O. ostertagi* is high. Baker *et al.* (2), in reporting on transmission studies of gastro-intestinal parasites between domestic sheep and Columbian black-tailed deer, noted that host specificity for species of the genus *Ostertagia* is much higher than for species of the genera *Trichostrongylus* and *Nematodirus*.

The poor ova production of *C. oncophora* is probably a manifestation of host specificity. In contrast to the findings in lambs, all calves were passing ova by the twentieth day and had egg counts ranging between 950 and 6,000 e.p.g. five weeks after exposure (10). It should be pointed out that all calves had patent *Ostertagia* infections which contributed to the egg count, although *C. oncophora* were the most prevalent species in all calves. Bremmer (3) also has reported a somewhat similar observation for *Haemonchus* in calves carrying mixed natural infections where maximum egg counts of the ovine form were much smaller than those of the bovine form.

The demonstrably smaller size of the majority of *C. oncophora* recovered from lambs is probably a still further result of host specificity. This dwarfing of *Cooperia* was observed in all lambs, even in one exposed only four weeks, which would suggest that acquired resistance is not a factor. Isenstein and Porter (5) have shown that the mean total length of *C. oncophora* larvae cultured in the feces of a parasite-free lamb was smaller, though not significantly, than the mean total length of larvae cultured in feces from a calf. Since the diet was the same for these animals, they thought the differences in larval size may be caused by individual differences in the utilization of the diet by the host animal, or differences in the microbiota of the feces. Regardless of what may be the actual mechanism governing the development of parasites in the various hosts, dwarfing is apparently not confined only to *C. oncophora*. Herlick *et al.* (4) also observed a similar phenomenon with the bovine strain of *Haemonchus* from experimentally infected lambs which were significantly shorter than those recovered from similarly affected calves.

A study of the weight gains recorded during this trial might suggest that the poorer weight gains observed in the infected lambs kept beyond a month after exposure are the result of parasitism, especially when marked clinical symptoms were observed in calves on the same pasture (10). It should be pointed out that the paddock in which these lambs were kept was quite small to insure that close grazing and a maximum pick-up of parasites would occur; consequently, available food was minimal. In the absence of clinical signs of disease, the lack of adequate grazing was believed to be at least partially responsible.

The reason that the non-infected lambs were placed on infected pastures which had remained vacant over winter was to study the role of residual infection in addition to the cross-transmission of parasites. Previous work (10) had indicated that the bovine species studied are the principal gastro-intestinal parasites in Maritime cattle and that they do survive

on the pastures over winter. Therefore, based on the trial just concluded, it would appear that under natural grazing conditions, cattle play a relatively minor role in the establishment of parasitism in sheep under Maritime conditions.

Summary

Cross-transmission studies revealed that parasite-free lambs, when placed on a pasture grazed by heavily parasitized calves the previous grazing season, picked up *Cooperia oncophora*, *Trichuris ovis* and *Moniezia benedeni*.

Ostertagia ostertagi and *Nematodirus helvetianus* did not establish in lambs although large numbers were recovered from calves on the same pasture.

The largest number of *C. oncophora* recovered from a lamb was less than 6,000, while calves on the same pasture had an average exceeding 32,000.

Ova production of *C. oncophora* in lambs was negligible. The size of *C. oncophora* in lambs was appreciably smaller than those recovered from calves. The evidence suggests that a relatively rapid resistance develops against *C. oncophora* in lambs, causing a marked reduction or "throw-off" of parasites.

Clinical signs of disease in the lambs, attributable to the presence of bovine parasites, were not apparent. The results of the trial suggest that cattle probably play an insignificant role in perpetuating parasitism in sheep on the community pastures and possibly elsewhere in the Maritimes.

Résumé

Des études par transmission croisée ont révélé que des agneaux n'ayant aucun parasite lorsqu'on les mettait à un pâturage où, la saison précédente, on avait fait paître des veaux infestés de nombreux parasites, ramassaient les parasites suivants: *Cooperia oncophora*, *Trichuris ovis* et *Moniezia benedeni*.

Les agneaux n'étaient pas affectés par les parasites *Ostertagia ostertagi* et *Nematodirus helvetianus*, en dépit du fait qu'on en avait trouvé en grandes quantités chez les veaux mis au même pâturage.

On n'a jamais trouvé plus de 6,000 *C. oncophora* sur un agneau, tandis que les veaux mis au même pâturage avaient en moyenne au-delà de 32,000 de ces parasites.

Chez les agneaux la production des œufs du parasite *C. oncophora* était négligeable. Et la taille de ce parasite était plus petite chez les agneaux que chez les veaux. Ceci montre que les agneaux développent une résistance relativement rapide contre les parasites *C. oncophora*, entraînant ainsi une réduction marquée ou un rejet de ces parasites.

Il n'y avait aucun signe clinique apparent de maladie chez les agneaux, attribuable à la présence de parasites bovins. Les résultats de l'épreuve semblent indiquer que le bétail ne joue qu'un rôle de peu d'importance dans la transmission de parasites chez les moutons mis aux pâturages communautaires et possiblement ailleurs dans les Maritimes.

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BOOK REVIEW

Pathology of Domestic Animals. Volume I. K. V. F. Jubb and P. C. Kennedy. Academic Press Inc., New York and London. 1963. 477 pages. Price $19.44.

This volume has seven chapters dealing with: bones; joints and synovial structures; the circulatory system; the respiratory system; the haemopoietic system; the endocrine glands; the male genital system; and the female genital system.

In devoting a chapter to each system, the authors have followed the example of their medical colleagues, and have departed from the usual format which has been followed by authors of veterinary pathology texts for too long. Each subject is presented in a detailed and comprehensive manner and the style, in general, makes for easy reading. There are few typographical errors. For those who wish to read more extensively on a given subject, an excellent bibliography is provided at the conclusion of each chapter. It is felt that the inclusion of a small section reviewing the normal structure and function of each organ and system, as is done in some texts of human pathology would improve the usefulness of this text. The chapters dealing with the endocrine glands, and male and female reproductive systems, are welcome additions to the literature. Those who are interested in avian or fur-bearing animal pathology will be disappointed. The extensive use of excellent photographs, dealing with both gross and microscopic pathology, contribute much to the value of this book.

More subheadings in bolder type print would facilitate use of the text. The index appears to be the weakest point of this two-volume work. This reviewer is unaware of the considerations that make authors and publishers decide on two volumes instead of one. Unless a reader takes the time to memorize the subjects dealt with in each volume it is frustrating to pick up the wrong volume and search through the index for something that isn't there. It is felt that this could be largely overcome by having an index in each volume which covers the complete work. The use of consecutive page numbers in the two volumes might also be considered. To illustrate the confusion, on page 256 there is a statement: "a detailed consideration of the passive transfer of antibodies through the colostrum and across the placenta has been given under colibacillosis". There are two page numbers for colibacillosis in the index, neither of which deals with this aspect of the subject. It is dealt with in Volume II. Under swamp fever in the index, we are told to "See equine infectious anaemia" but no page number is given. It would seem a simple matter to include the page number there as well.

This volume, combined with its companion, is undoubtedly the best text dealing with the pathology of domestic animals, available to date. It is a must for every student, teacher, practitioner, and researcher. *A. H. Corner.*