quantity of soft fæces passed. Same evidence of abdominal pain continued. Conjunctival mucous membranes injected. Chlorodyne as before.

15th February. Temperature 101° , pulse 46, respirations 12. Animal frequently lies down and rises, evidence of rather more severe, though not violent, pain; small quantity of fæces passed. Chlorodyne continued, and morphia injected subcutaneously.

16th February. Temperature 102° , pulse 48, respirations 18. Condition same as on 15th. Treatment repeated.

17th February. Temperature 103° , pulse 89, respirations 24. Evidence of abdominal pain more marked but not violent; some tenesmus; vessels of conjunction intensely congested. Seven grains of morphia subcutaneously three times.

18th February. Temperature 102.6° , pulse 99, respirations 24. Depression very marked, heart-beats feeble, no fæces passed, a small quantity of thick urine, tenesmus, and evidence of abdominal pain, less marked towards evening. Treatment continued.

19th February. Died early in the morning.

The autopsy revealed intense muco-enteritis of large areas of the cæcum and colon. Other viscera healthy. Myriads of minute strongyles on the inflamed mucous membrane. No parasites were noticed before death, as frequently may be done in the fæces or on the arm after rectal exploration.

INTESTINAL PSOROSPERMOSIS IN LAMBS.

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THE term psorospermiosis is applied to diseased conditions caused by the so-called psorosperms, which are animal parasites, most of them microscopic in size, and all of them comparatively simple in structure. The best known of these parasites is the coccidium oviforme, which is parasitic in the bile ducts of the rabbit—wild and domesticated, and which is a not infrequent cause of serious mortality in that species. In a former article¹ I described this parasite, and the lesions which are set up by its presence in the rabbit's liver; and at the same time I recorded some observations that I had made regarding an identical or nearly related coccidium which was responsible for a very heavy mortality in young pheasants. The pheasant coccidia inhabited the intestinal epithelium, which, in consequence of their presence, was in a large measure destroyed.

Since the above-mentioned article was published, I have discovered the same parasite in other outbreaks of disease, both among young pheasants and adult domestic fowls; but the object of the present note is not to record any new observations made regarding this avian psorospermiosis, but to describe a recently encountered form of this disease, which is of greater interest owing to the species attacked, and the nature of the lesions excited.

In the month of April last, in making a *post-mortem* examination of a lamb which had been forwarded to me after death for that purpose, I discovered in the small intestine a considerable number of reddish

¹ Vol. VII., p. 131, of this Journal.

pear-shaped tumour-like bodies, mostly about two or three times the size of an oat seed, and sessile on the mucous membrane. Apart from the presence of these growths, the lining membrane of the bowel was at some places the seat of a diffuse inflammation, attended with marked injection of the small vessels of the villi. When the fluid obtained by squeezing one of the tumours was examined under the microscope it showed large numbers of oval coccidia, similar to the *coccidium oviforme* of the rabbit, but distinctly smaller.

A few days after the before-described case was examined I paid a visit to the farm on which the lamb had died, and I was fortunate enough to find there another member of the flock in a moribund condition, from what was regarded by the shepherd as the same disease. This lamb was killed and submitted to *post-mortem* examination, with exactly the same result as in the first case.

On microscopic examination the small tumours of the bowel are found to have a very interesting structure. They appear to have been produced by an irregular hyperplasia of the mucous membrane, including both the villi and the glandular stratum. The former are enlarged and somewhat distorted from an overgrowth of their central adenoid tissue and surface epithelium, but at some places, especially towards their tips, they are quite denuded of their epithelial covering. The bulk of each tumour, however, is seen to be made up of the altered glandular layer of the bowel wall, in which the crypts of Lieberkühn show an appearance that strongly recalls an adenomatous growth. The single layer of columnar cells which forms the normal lining of these glands is for the most part represented by a stratified epithelium, in which at some places as many as ten or more strata of close nuclei may be counted. At a few places, as in the case of the villi, the epithelium is entirely destroyed. The adenomatous type of structure is due to the fact that many of the glands show irregular lateral diverticula, lined like the parent gland with an abnormally thick epithelium. Between the irregularly overgrown glands the adenoid tissue appears to be increased in amount, though not notably altered in structure.

All of these points are readily observed on inspection of a well-prepared section with a low power, and even with a low magnification one can detect here and there in the epithelium of the glands or villi the larger coccidia, while with higher magnification immense numbers of the smaller parasites are brought into view.

The smallest coccidia are present in large numbers in the proliferated epithelium of the villi and the glands of Lieberkuhn. In both positions they are most abundant in the surface layer of columnar cells, and the majority of them occupy the outer part of the cell body. In the normal epithelium the nuclei are situated towards the deep ends of the cells, but in the epithelium invaded by the young coccidia the outer half of each cell appears to be dotted with minute nuclei. When sufficiently magnified, these are found to belong to the smaller coccidia, which have a diameter of about $2.7\ \mu$, while their nuclei measure about $1.7\ \mu$. The cell substance of these small coccidia is clear, unstained (in alum-carmin), and homogeneous even under a high magnification.

A point of very great interest in connection with these small bodies is that very many of their nuclei present an appearance which is

strongly suggestive of division. In a considerable proportion of them two nuclei are present separated by a narrow clear line, as if the nucleus had just divided into two. Such figures have a close resemblance to the diplococcus form of dividing micrococci.

Coccidia a little larger than these apparently youngest forms have more cell-substance, and with further growth the central spherical nucleus (which stains well with alum-carmine) comes to be surrounded by a narrow halo-like zone, while the cell-substance becomes filled with minute granules. These "gregaina granules" become much coarser as the coccidium approaches its full size, and, as they stain with carmine, they generally completely mask the nucleus in the larger parasites. As the final developmental step observable in the intracellular parasites, they assume an oval shape and acquire a double-contoured cuticle or shell. Just before the latter makes its appearance the granules are often arranged with marked regularity at the surface of the cell-substance. The mature shelled coccidia have a long diameter of about 20μ , while their transverse measurement at their widest part is about 14μ . Save in point of size they differ in no way from the coccidium oviforme of the rabbit's liver, or the variety which I have previously described from the intestine of the pheasant. No cultivation experiments were attempted and I am therefore unable to say anything regarding their subsequent transformations. Probably, their contents, as in the case of the rabbit coccidia, at a later stage (either in the intestine or external to the body) become transformed into spores, which, when they gain access to the body of a new host assume an amœboid form and start a fresh cycle of development. But on *a priori* grounds, as well as on account of the signs of nuclear division already referred to, it may fairly be assumed that an actual multiplication of the parasites does go on within the body of the host. In the first place it is wholly incredible that every individual coccidium found in the intestinal epithelium can have been ingested by the host, for on such an assumption it would be quite impossible to explain why great numbers of young coccidia are found side by side in the same gland, while other glands only a short distance removed are quite free from parasites. In whatever way the spores or young coccidia gain access to the alimentary canal, one must imagine that they have a fairly uniform distribution in the alimentary matters by the time that they reach the small intestine, and therefore one would expect to find a tolerably uniform invasion of the epithelium; and, assuming, that large numbers of parasites are ingested on successive occasions one would also expect to find coccidia in all stages of development side by side. Instead of that, however, the invasion of the epithelium is by no means regular in its distribution; and, while one does find here and there both young and mature forms near one another, that is the exception rather than the rule. On these grounds it appears much more probable that, just as with bacterial diseases, infection is generally by means of a small number of individuals, and that these multiply either while free in the bowel or after they have invaded the epithelium. When one reflects that in even the most favourable circumstances only a very small proportion of the coccidia which are passed out with the excreta are likely to find their way into the body of a new host, and that only a small number of the so-called spores (four to eight) are formed in a single coccidium, it seems quite impossible to

account for the continuance of the species without conceding the power of direct multiplication to all the individual coccidia.

As already mentioned, the small pyriform tumours were not the only lesion present in the bowel, for the mucous membrane showed more or less inflammatory congestion, and on microscopic examination it is found that many of the villi not involved in the tumour-like formations are absolutely denuded of their epithelium and show extreme distension of their capillaries with blood. It is indeed probable that this alteration, to a much greater extent than the development of the small tumours, was responsible for the diarrhœa from which the lambs suffered at the end, and for the fatal termination of the disease. The lambs, it may be observed, were from two to three months old, and in a period of about one month there had been a mortality of nearly 10 per cent.

Death usually resulted within forty-eight hours after the onset of the symptoms, which were dulness, loss of appetite, diarrhœa, and tympanitic distension of the abdomen. The lambs at the time when the disease broke out in the flock were closely folded together with the ewes on growing roots, which, needless to say, were much soiled with earth and fæces before they were completely consumed. Assuming that the coccidia passed out with the excreta are capable of infecting other individuals, one can hardly imagine circumstances more favourable for the spread of the disease than those which were in existence in this flock. The disease appeared to attack the lambs the ewes seemingly being able to resist infection.

So far as I am aware, this is the first instance in which intestinal psorospermiosis has been observed in sheep in this country, and I know of only one similar observation abroad, viz., by Professor Nocard, who contributed a note on the subject to the Seventh International Congress of Hygiene and Demography. This note was afterwards published, together with an illustration, in the *Journal of Pathology and Bacteriology* (Vol. I., p. 404). The mature coccidia are there described as being only 10 to 12 μ in their long diameter, whereas in the cases here recorded they were nearly double that size. Professor Nocard was inclined to regard the coarse granules which appear in the cell-substance of the larger coccidia as spores, and on that account, and because of their smaller size, he concluded that the ovine coccidia do not belong to the same family as the coccidium oviforme of the rabbit. But in my preparations the full-grown coccidia have a long diameter nearly double that given by Professor Nocard, and whatever may be the nature and purpose of the "granules" they can hardly be regarded as spores, inasmuch as their formation is certainly not preceded by division of the central nucleus. It is true that in most cases the nucleus is no longer discernible in the coccidia with large coarse granules, but probably that is because these granules mask its presence, for with a careful search one finds here and there a coccidium in which the central but now faintly stained nucleus can be made out although the large round granules are present in the cell substance. Moreover, the formation of these granules can hardly be regarded as sufficient ground for placing the ovine coccidia in a different family from the coccidium oviforme, for similar though considerably smaller granules make their appearance in the rabbits coccidia before they acquire the shell.

DESCRIPTION OF PLATE I.

Fig. 1. Psorosperm tumours of lamb's intestine ($\times 9$); *a*, the centre of the tumour, representing the submucous coat; *b*, mucous membrane of the wall of the small intestine cut vertically; *c*, the same cut obliquely.

Fig. 2. Portion of the same tumour ($\times 58$); *a*, a group of mature shelled coccidia. Smaller groups of coccidia are visible at several other places in the epithelium.

Fig. 3. Portion of a gland of Lieberkühn ($\times 250$); *a*, lumen of the gland; *b*, epithelium with numerous small nucleated coccidia in its superficial stratum; *c*, interglandular adenoid tissue.

Fig. 4. Portion of another gland ($\times 370$); *a* and *b*, as in preceding figure.

Fig. 5. Portions of villi at surface of tumour ($\times 370$); *a*, a nearly mature coccidium, showing some granules in its interior, and others arranged as a ring at its surface; *b*, a mature shelled coccidium. Numerous other coccidia in various stages of development are seen in the epithelium or replacing it.

Fig. 6. Epithelial lining of an invaded gland ($\times 714$); *a*, proliferated nuclei of the epithelium; *b*, superficial part of the epithelium invaded by young nucleated coccidia.

 EDITORIAL ARTICLES.

THE STAMPING OUT OF GLANDERS.

WE have on several occasions in these columns dealt with this subject, but we do not think that we owe any apology to our readers for again returning to it. Judging by the small impression that has been made on the disease during the last twelve months, it seems only too plain that the measures now being enforced stand in need of some alteration. The extermination of the disease, even in London and other large centres, is no longer an impossible task, and if it is not effected within the next few years a great reproach will lie with the veterinary profession for not having urged the adoption of regulations adequate to the end in view, or with Local Authorities for not having adopted the counsel offered them.

Let us see, in the first place, what is now being done in London (which furnishes 70 per cent. of all the cases of glanders reported during the year) with the object of eradicating or checking the disease. When an inspector to the Local Authority discovers or has brought to his notice a horse which is, in his opinion, the subject of glanders or farcy, that horse is slaughtered, and the carcase is so dealt with as to render it innocuous, while in compensation for the destruction of the carcase the owner is allowed £2. The stall or loose-box in which the horse has been standing before his slaughter is cleansed and disinfected. If there are other horses in the same stable these are examined by the veterinary inspector, but, provided that no lesion commonly accepted as indicative of glanders is detected in any