Attachment of the Sheep Hookworm to the Common Sheep Tapeworm

THE study of the manner of feeding of the nematodes inhabiting the alimentary canal of vertebrates is one of the comparatively recent developments of helminthology. Hoeppli, Wetzel and others have shown that many nematodes which possess a well-developed buccal capsule—typified in the Strongylidæ and the Ancylostomidæ—are probably tissue feeders. Thus Wetzel[1] describes the feeding habits of *Chabertia ovina* (Gmelin, 1790) from the large intestine of the sheep and says:

"Longitudinal sections of specimens attached to the mucosa show that the worms have drawn a portion of the stratum glandulare into the sub-globular toothless buccal capsule. On its base the tissue is strongly pressed together by the mouth wall and the anterior margin of the buccal capsule, forming a neck-like constriction. Opposite the place to which the parasite is attached a flexure is to be seen in the muscularis mucosa and in the sub-mucosa . . . As to the marked regressive changes of the swallowed tissue and the necrotic masses at the bottom of the buccal capsule we have to assume further a histolytic action of the parasite. . . . From a general physiological point of view the whole process is nothing other than a pre-digestion of the elements of the propria mucosa before they are swallowed by the worm."

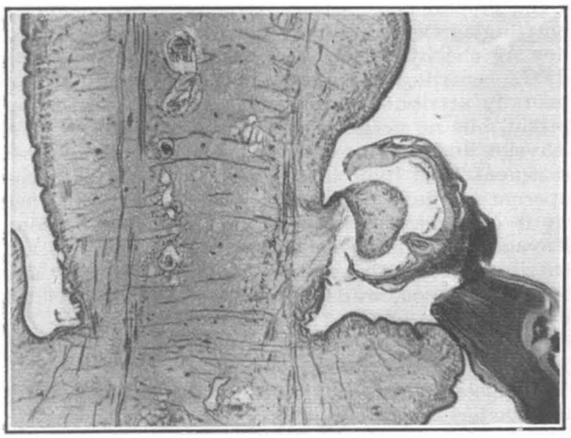

Fig. 1.

On two occasions during the past two years, in the course of frequent examinations of the fresh intestinal contents of sheep for nematodes, I have seen *Bunostomum trigonocephalum*, the sheep hookworm, attached to *Moniezia expansa*, the common sheep tapeworm, though, presumably, it is usual for this hookworm to satisfy its food requirements through the mucous membrane (hæmoglobin may be demonstrated in the worm). In one case, attempted fixation of the parasites to show their relationship was unsuccessful, the *Bunostomum* coming away on immersion in Carnoy, but in the other case the attachment was secure enough to overcome the tendency of the worms to contract on fixation. The accompanying photograph (Fig. 1) illustrates a section through the point of attachment. Although the cestode tissue is badly contracted, seemingly because of the unsuitability of Carnoy as a fixative, it will be seen that the effect of the *Bunostomum* on the cestode tissue is much like the effect of *Chabertia* on the mucous membrane as described by Wetzel. There is a similar withdrawing of a portion of tissue into the buccal capsule, a similar constriction of it at the mouth margin, and a similar tendency, as shown by the transverse muscle fibres, for the deeper lying structures to be drawn down towards the hold of the nematode. Finally, a certain amount of regressive change has taken place in the tissue within the buccal capsule, and the cestode cuticle, the sub-cuticular layer, and the sub-cuticular cells have all been destroyed.

While from this one example, it would be too much to say that *Bunostomum* utilizes *Moniezia* as a source of food, in addition to anything it derives from the mucous membrane, yet the occurrence of this one case has an interesting bearing on the factors which lead the nematodes of the alimentary canal to the mucous membrane. I have so far failed to demonstrate any chemotropic effect the membrane may have on these nematodes, but their possession of a strongly developed stereotropism is readily shown in many ways. They will swim freely in a suitable solution until contact with a membrane surface or its equivalent is attained and then, for some considerable time, they will remain at the surface. Would this stereotropism be sufficient to keep them at the mucous membrane, and is the mere presence of the tissue sufficient stimulus to cause them to feed, or at least, attempt to feed? Or, after all, does the mucous membrane exert a chemotropic effect on the nematodes, and is this particular *Bunostomum* an example of one that has failed to respond?

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[1] Wetzel, R., *North Amer. Vet.*, 12, 9, 25–27 (1931).

Structural Laws of the Mammalian Kidney, with a Theoretical Derivation

THE structural laws to be described, though independent of theory, may be derived from certain general principles arising out of a 'diffusion-pressure' theory of the kidney. This theory has already been developed to some extent[1]. The principles of derivation are as follows:

(*a*) The renal secretory cells are equivalent in action throughout the Mammalia, and their function is to create a diffusion pressure of urea, etc., in the direction of the lumen.

(*b*) The shape of the kidney and the relations of tubule length to renal length remain uninfluenced by body weight.

(*c*) The mammalian kidney is so constructed that the mean blood and urine concentrations remain independent of the size of the animal.

From the first principle, the following equation may be derived:

$$V(C_U - C_B) = P\, C_B\sqrt{Vknl} \quad . \quad . \quad . \quad (1)$$

Here V is urine rate; C_U, C_B are the urine and blood concentrations; l is the length of the secreting tubule; k is the diffusion coefficient of urea, etc., which may be regarded provisionally as the diffusion coefficient through the tissue; P is a constant. As will be shown later, slight modifications make this equation independent of all changes of blood and urine volume.