

anharmonicity (2 per cent), except in the case of two of Linnett and Thompson's, and one of Bonner's predictions. It is also noticeable that an observation of ν_9 would be another extremely helpful criterion, since here the predicted values show the widest spread. Work is being continued on the location of ν_9 .

G. B. B. M. SUTHERLAND.
G. K. T. CONN.

Laboratory of Physical Chemistry,
Cambridge.
Sept. 6.

¹ de Hemptinne, M., Jungers, J., and Delfosse, J., *NATURE*, **140**, 323 (1937).

² Manneback, C., and Verleysen, A., *NATURE*, **133**, 367 (1936); *Ann. Soc. Scient. Bruxelles*, B, **56**, 349 (1936); **57**, 31 (1937).

³ Sutherland, G. B. B. M., and Dennison, D. M., *Proc. Roy. Soc., A*, **148**, 250 (1935); Sutherland, G. B. B. M., *Proc. Roy. Soc., A*, **141**, 355 (1933) for treatment of ν_{11} .

⁴ Thompson, H. W., and Linnett, J. W., *J. Chem. Soc.*, 1376 (1937).

⁵ Bonner, L. G., *J. Amer. Chem. Soc.*, **58**, 34 (1936).

Physiology of Nematodes

THE initial success, or failure, of a primary infestation of a host by parasites must be largely the result of the effect on them of the environmental conditions provided by the host, conditions which must also control their distribution within the host. Unfortunately, little is known of the reactions of parasites to definite features in their environment, and in order to help relieve the paucity of our knowledge of these problems, experiments were made with nematodes from the alimentary canal of sheep.

Before the experiments could begin, it was necessary to make an attempt to settle the controversial question of the respiration of parasitic nematodes. Most workers, mainly as a result of experiments with various species of *Ascaris*, believe them to be anærobic, but I was forced to conclude that nematodes from the sheep, at least, have an aerobic existence. They are killed by periods of oxygen-lack greater than forty-eight hours, even when arrangements are made for any by-products of their metabolism which may have permeated their cuticle to be removed from their environment.

Studying the effect on the nematodes of solutions of varying pH, it was found that the lower limit of acidity tolerated by *Ostertagia circumcincta* (pH 3.2), a species normally found in the abomasum or digestive stomach of the sheep, was not low enough to allow it to live in the stomach of animals such as the dog or horse, or in the abomasum of cattle. The lower limits without adverse effect on the species from the small intestine are not low enough for them to parasitize the abomasum.

In an infestation by nematodes of the small intestine of sheep, the various species inhabit more or less definite regions, each characteristic of the species. It was found that the distance of these 'regions' from the bile duct opening could be correlated with the effect of sodium glycolate and sodium taurocholate on the different species. Thus the peaks of infestation of *Trichostrongylus colubriformis* and *T. vitrinus* occurs within about five feet of this opening, while those of *Nematodirus* sp. and *Cooperia* sp. are not within nine or ten feet of it, and it is *Trichostrongylus* which withstands the greatest concentration of bile salts.

An effort was also made to discover the food of the nematodes—the species dealt with are *Trichostrongylidae* and are not found attached to the mucous

membrane. The demonstration of hæmoglobin within them was not taken as proof of their blood-sucking habits; indeed, the evidence leads to the conclusion that nematodes of the alimentary tract synthesize this substance for themselves, presumably because it is a necessary constituent of their bodies if they are to live an aerobic existence. No definite indication of their actual food was obtained. Bacterial difficulties hampered the experiments, but in one series, when they were overcome by placing *Ostertagia* in an apparatus whereby abomasal fluid could be percolated over the worms, they lived no longer than the controls in Ringer-Locke solution. The attempts at blood-feeding with this species and with those from the small intestine also failed to keep the worms alive longer than 'starving' controls. As yet, only tentative conclusions can be drawn, but it seems that something to be found at or in the mucous membrane of the intestine, possibly the tissue itself, must be incorporated into the experiments before the culture of adult nematodes will be successful.

A full account of the experiments will be published shortly.

D. G. DAVEY.

Institute of Animal Pathology,
University, Cambridge.

Effects of Salts on Emergence from the Cyst in Protozoa

THE physiology of encystment and excystment of Protozoa and other micro-organisms has received little attention. In the case of the ciliate *Colpoda cucullus*, it has been earlier shown¹ that emergence from the cyst, or excystment, is brought about by some special substances present in the excysting medium, which is usually hay infusion. Part at least of the active material was shown to be ether-soluble. We have therefore subjected hay infusion to fractionation in order to isolate and identify the active excysting substance.

It was found unexpectedly, however, that excystment is not due to a special substance but is a property of the salts of a number of organic acids of low molecular weight. There were identified, in the ether extract of an infusion of timothy hay, oxalic, succinic, acetic, fumaric, tartaric, malic and citric acids, these being either isolated or determined by methods in the literature. The potassium salts of all these were active, to varying extents, in causing excystment. Activity is a property of the salts and not of the free acids, potassium and sodium salts being about equally active.

Since activity varies widely among the different acids, this provides perhaps the most favourable opportunity yet known for studying the relation between chemical structure and a biological activity. Preliminary results of this part of the work indicate that, in a homologous series, activity decreases with increasing molecular weight, heptylic and azelaic being the upper limits with mono- and dibasic-acids respectively. Activity is greatly increased by the presence of a hydroxy group in the β -position, but apparently decreased when it is in the α -position.

In an attempt to account quantitatively for the activity of hay infusion in terms of its content of known acids, two important modifying factors have been disclosed. First, the ether-insoluble residue considerably increases the activity of the salts of the various acids, although it possesses little activity