There is general agreement that there are three principal methods of prophylaxis of dental caries, namely, administration of fluorides by vehicles other than water supplies, such as tablets, milk, common salt, flour and bone-meal, which the committee cannot recommend until further investigations have been made; topical application of fluoride to the teeth, which should, the committee thinks, be investigated clinically under the control of the Royal Medical Board; and fluoridation of the public water supplies.

With regard to this last method, the Board now reports that fluoridation of public water supplies does not involve any demonstrable hazards to health. It should, however, be carried out under strict control and care should be taken that, where it is instituted, the people are not exposed to fluorides derived from any other sources, such as foods or industrial gases. The Board reports that it has been found that a concentration of about 1 mgm. of fluoride per litre of water will reduce the incidence of dental caries by about 50 per cent in children and young persons who have consumed this water all their lives. In other children the caries will be reduced roughly in proportion to the period of consumption of the water. Fluoride also seems to protect the teeth of middle-aged people. A slight mottling of the enamel of the teeth appears in some children who have drunk water containing 1 mgm. of fluoride per litre during the period of tooth formation.

The technique of fluoridation of water is simple and has been thoroughly tested, but it is not applicable to those large groups of people in Sweden who have no access to a public water-supply. In Stockholm and Gothenburg the costs of fluoridation have been estimated at 0·3–0·4 Swedish crowns per person per year, or, when it is restricted to school children, 3–4 crowns per child per year. At present, expenditure on the public dental service for school children is about 75 crowns per child per year, and dental caries is so widespread that all available means of combating it must be used. In Sweden the city of Norrköping fluoridized one of its two public water supplies five years ago, and in Uppsala, Eskiltuna and Hälsingborg the public water supplies naturally contain more fluoride than is used for artificial fluoridation. The Board points out that in other countries in which fluoridation is used no evidence has been found that it harms health, and that both the American Medical Association and the World Health Organization have unreservedly recommended fluoridation as an effective and safe means of preventing dental caries.

The World Health Organization Expert Committee on Water Fluoridation, in its first report*, also concludes that drinking water containing about 1 p.p.m. fluoride has a marked preventive action on caries and does not impair health, and that controlled fluoridation of water is a practicable and effective public health measure. G. Lapage

* World Health Organization. Technical Report Series, No. 146: Expert Committee on Water Fluoridation—First Report. Pp. 25. (Geneva: World Health Organization; London: H.M. Stationery Office, 1958.) 1 Swiss franc; 1*s.* 9*d.*; 0.30 dollars.

HOST — PARASITE RELATIONSHIPS

THE subject of host – parasite relationships covers such a wide field that the four papers on this subject, presented on September 3 in Section *M* (Agriculture) of the British Association meeting in Glasgow, not unexpectedly had comparatively little in common. Nevertheless, this diversity of interest helped to emphasize the fact that few living creatures escape the attention of some parasite or other, and that many specialized adaptations are necessary for parasitic life. Equally elaborate defence mechanisms have been evolved by potential hosts. The struggle for survival is governed very largely by the efficiency of these predatory or defending mechanisms.

Dr. J. A. Campbell (Moredun Institute, Edinburgh) explained that, among the insects, the true flies or Diptera apparently adopted the parasitic mode of life comparatively late in their evolutionary history. For this reason the flies show various degrees of adaptation to parasitism which can provide some information on the probable course of development of the habit. Morphological studies provide good evidence that the blood-sucking habit was evolved independently at different times in the various families. The behaviour patterns among the higher flies (Cyclorhapha) suggests that the course of evolution developed from generalized feeding on a wide variety of hosts to a more specialized association within a narrow range of hosts and even to complete dependence on a single species.

The stable fly (*Stomoxys calcitrans*), for example, feeds on a wide range of hosts, including man and most farm animals. Its larvæ can live in a variety of decomposing material, including dung heaps. The horn fly (*Lyperosia irritans*) is more specialized. The adults feed only on cattle, while the larvæ are confined to cattle dung. In the case of the sheep tick (*Melophagus ovinus*) dependence on a single host is complete. The fly has no wings, its larvæ are nourished *in utero*, and pupation occurs on the host.

There are many examples of the development of allergic sensitivity to insect bites. In some cases this can be recognized as a distinct clinical syndrome, such as Queensland itch in horses due to attacks of *Culicoides*. Insect saliva has been shown to be antigenic and the injection of this saliva can lead to the development of neutralizing antibodies in the host. So far as the hosts of blood-sucking flies are concerned, there is little doubt that for a variety of reasons some members of a species are more resistant to attack than others. There is no evidence, however, that specific immune reactions have any effect on the rate of infestation.

Dr. J. R. Norris (University of Glasgow) discussed the result of some recent work, largely done by two Canadian workers, Hannay and Angus, on the spore-bearing bacteria, *Bacillus thuringiensis*, which infect meal moth larvæ, and *Bacillus sotto*, which cause a septicæmic disease of silkworms.

Both organisms are capable of developing large protein crystals within their cytoplasm. If silkworm larvæ are fed with cultures of *B. sotto* containing both spores and protein crystals, they first become

paralysed and then develop a septicæmia as the bacteria penetrate into the body cavity. If the same culture is injected into the body cavity, the organisms multiply and produce a septicæmia but no paralysis occurs. The spores themselves are harmless if fed without the protein crystals, although they cause a septicæmia without paralysis if injected into the body cavity. The protein crystals can be extracted from the bacteria and cause paralysis and death if fed to the larvæ, but not if injected into the body cavity.

It seems, therefore, that the protein crystals are necessary for the penetration of the bacteria through the gut wall, and that the protein itself requires to be activated by the gut contents before it becomes toxic.

Dr. Norris also discussed the possible relationships between *B. cereus*, *B. thuringiensis*, *B. sotto* and *B. anthracis*. It is quite clear that there are a number of interesting problems to be solved in connexion with the pathogenicity of this group of organisms.

Dr. W. Mulligan (University of Glasgow) described the results of recent work on parasitic bronchitis of cattle which has been done at the University Veterinary School. This disease, caused by the lung worm *Dictyocaulus viviparus*, is responsible for serious debility among calves both in Britain and abroad. Severe attacks can be fatal. The disease may sometimes be cured by drugs which destroy the worm in the bronchi, but the treatment is usually too late to prevent severe damage to the lungs. Nevertheless, cattle gradually develop a satisfactory immunity after repeated exposure to natural infections. Dr. Mulligan and his colleagues have shown that calves can be protected against experimental infections of lung worms by injections of immune sera from animals which have recovered from the disease. This demonstration of the passive transfer of immunity has shown beyond all reasonable doubt that calves can produce protective antibodies against *Dictyocaulus viviparus*. The knowledge that circulating antibody can protect calves is of great value and a step forward in our understanding of the disease. Unfortunately, for practical reasons, this method of immunization cannot be used on the average farm. There is little doubt that the best method of prevention would be to find some means of artificially inducing an active immunity in otherwise susceptible animals. Attempts to immunize calves with various preparations of dead lung worms were apparently not very successful.

As natural infections gradually produce an active immunity, a trial was made with living vaccines consisting of larvæ which had been exposed to X-rays. It was hoped that larvæ treated in this way would survive for long enough in the calf to stimulate an active immunity and yet be incapable of causing progressive disease. Living vaccines of this type show great promise. It is thought that two doses of vaccine may give the best results, and an intensive trial is being made of this method. If these trials are successful, this vaccine should be of the greatest value to cattle owners in all parts of the world.

Dr. J. J. Bullen (Rowett Research Institute) discussed some of the factors which can influence the multiplication of pathogenic bacteria within a host. Examples were chosen from two experimental infections, enterotoxæmia of sheep and *Clostridium welchii* type *A* infections in embryonated hen's eggs.

The organism responsible for enterotoxæmia of sheep, *Cl. welchii* type *D*, is a normal inhabitant of the intestine. In certain circumstances, these bacteria multiply extremely rapidly and produce large quantities of toxin which is absorbed and kills the sheep. The disease cannot be reproduced in normal sheep fed on ordinary diets such as hay even if large numbers of *Cl. welchii* type *D* are introduced directly into the intestine. Viable counts of the bacteria in the living animal show that the bacteria cannot multiply fast enough to maintain their numbers and are soon removed by the normal flow of the intestinal contents. If the diet is suddenly changed, to wheat, for example, and the sheep overeats, the rumen becomes filled with undigested food. In the intestine this provides an ideal substrate for *Cl. welchii* type *D*. Very large numbers of the bacteria accumulate in the intestine. Large quantities of toxin are produced and the animal dies from acute enterotoxæmia. Thus, the diet of the sheep appears to play an important part in the development of this disease.

The experiments with eggs show that suitable antisera and, in certain circumstances, normal sera, can protect embryonated hen's eggs against normally fatal infections with *Cl. welchii* type *A*. The sera and bacteria are injected into the allantoic cavity. In unprotected eggs the organisms grow in the allantoic fluid and then invade the tissues of the embryo. In protected eggs the growth of the bacteria stops after an hour or two. There is no cellular response on the part of the host and no phagocytosis. Experiments of this kind appear to be useful for investigating the effect of sera on the growth of pathogenic organisms in the living host.

J. J. BULLEN

CHARGE-TRANSFER PROCESSES

A SYMPOSIUM on "Charge Transfer Processes", sponsored by the division of the Chemical Institute of Canada devoted to physical chemistry, was held during September 4–5 at the University of Toronto. The meeting, which had been organized under the chairmanship of Dr. B. E. Conway (University of Ottawa), was concerned with various aspects of the physical chemistry of reactions in which transfer of a formal charge occurs. Both homogeneous redox reactions and heterogeneous electrochemical reduction and oxidation processes were considered. About seventy-five physical chemists from the United States, Great Britain and Canada attended the academic sessions. Twenty-seven papers were presented, and each author was allowed ten minutes to describe the essential results of his work, all papers having been preprinted and circulated to participants several weeks before the meeting. About half the total time of the meeting was devoted to erudite and lively discussion of the papers presented. The meeting was honoured by the presence of a number of invited speakers from overseas, including Dr. D. J. G. Ives (Birkbeck College, London), Dr. J. E. B. Randles (University of Birmingham) and Dr. R. Parsons (University of Bristol). Prof. A. Frumkin (Academy of Sciences, Moscow), who had been invited, sent a paper for presentation but was regrettably unable to be present. On the