Paper No. 43.

FOOT-AND-MOUTH DISEASE.

THE following summary of his address has been furnished by W. H. ANDREWS, M.R.C.V.S., D.Sc., Director of the Veterinary Laboratory, Weybridge, England.

Dr. Andrews referred briefly to the importance of the disease, not as a cause of mortality, but as a serious source of economic loss on account of the lowering of animals' condition, the interference with the milk supply, and, perhaps, particularly on account of the interference with normal trade, especially in animal products. The disease was, at present, of very great importance to most of the countries of Europe and, perhaps, to South America, and its importance to the territories of Africa and Asia might be expected to become very much greater in the future.

He described the experimental station at Pirbright, and the elaborate precautions that are taken in order to prevent, not only leakage of infection from the station to the surrounding farms, but also the accidental transmission of infection within the precincts of the station itself. The precautions that were necessarily adopted prevented any great multiplication of experiments; work could not be conducted with a number of different viruses at the same time without, at least, some risk of confusion and error, and progress under these conditions was necessarily slow. A great deal of use was made of the guinea-pig in these experiments, but the guinea-pig was used at Pirbright mainly as a convenient and cheap indicator of the presence or absence of living virus, and in all work intended to throw some light on the nature of foot-and-mouth disease itself it was necessary to use cattle or pigs. Sheep were, of course, susceptible, and, if otherwise suitable, they would doubtless have been used on account of their cheapness and the ease with which they could be handled. But the reaction to infection exhibited by a sheep was often difficult to appreciate, and, in general, sheep had not been found suitable for the work.

He referred briefly to the nature and difficulty of a number of problems confronting those who are working with virus diseases. He considered that one could not take it yet as definitely proved that viruses were actually living organisms, and he felt that many of the conclusions now drawn from the results of our experiments might not actually be sound. Most of our experiments, and the conclusions that we drew from them, were based on analogies with known facts concerning bacteria, and it was by no means certain that we were dealing with truly comparable organisms. There appeared to be no doubt that, in connection with studies of the viruses, we needed new technique and new conceptions.

He then dealt with the question of the plurality of types of virus. The existence of two quite distinct immunological types had first been described in France by Vallée, and, later, Waldmann and Trautwein had added a third type. It was now usual to recognize the existence of these three types, known as the O, A, and C types respectively. Some years ago Stockmann and Minett had examined a series of about twenty strains of virus, obtained from primary outbreaks in England.

Of these strains, one had been shown to be of the A type and the remainder were O strains. Recently, a long series of viruses from primary outbreaks in Great Britain had been examined at Pirbright. It was not always possible to type these viruses successfully, more particularly as some of them could not be satisfactorily adapted to small laboratory animals. In the majority of cases it had been possible to do this, however, and the work had fully confirmed that of Stockmann and Minett, in that the great majority of the strains had been proved to be of the O type. No A or C strains at all had been found in the series of the past two years, but a couple of strains had been encountered which were, apparently, of a type distinct from the three now recognized. Quite apart from this question of immunological type, viruses showed considerable differences in their virulence for the different species of domestic ruminants. There appeared to be no doubt that some viruses were very virulent for cattle while affecting pigs little, if at all, and it seemed that there were viruses that were particularly virulent for pigs; but, in the majority of cases, both cattle and pigs proved more or less equally susceptible. Differences were also observed in the nature of the disease set up by the inoculation of various strains. Some viruses, for example, most commonly caused an attack associated with a very high temperature, and with others there might be little or no fever; there were also differences in connection with the size and distribution of the vesicles.

In connection with the question of susceptibility to the disease, he referred to the adaptation of a virus to the guinea-pig by successive passages, the most reliable method of introduction being the intradermal inoculation into the pads of the feet. An observation of considerable interest and possible importance had recently been made at Pirbright, where a spontaneous case of the disease had been found in an ordinary brown rat. Another recent observation of very great interest was the discovery by Mrs. Burbury, of the Lister Institute, that the hedgehog is highly susceptible to the disease. She found that the disease spreads amongst hedgehogs with ease and rapidity, and that the animals themselves may suffer severely. Some experiments of considerable theoretical interest had been undertaken by Mrs. M. Maitland with the object of throwing light on the fact that the lesions of the disease are confined to certain areas, such as the feet, the general skin surface being invariably quite free. Working with guinea-pigs, and with the aid of grafting operations, she had shown that the important factor was not the actual nature of the hairless thickened dermis, which is found on the soles of the feet, but lay, rather, in the presence or absence of pressure.

A good deal of work had been done at Pirbright with the object of determining the stage of the disease in cattle at which the animal first becomes naturally infective. A number of workers had investigated this point, and their general conclusion appeared to be that the period of greatest infectivity preceded the appearance of vesicles, that is, that the animal was most infective at a time when it might well escape detection and appear to be healthy. On this point their work at Pirbright did not confirm that of other investigators. In a number of experiments at Pirbright it had seemed to be established that an animal was rarely infective before there were actually ruptured vesicles in the mouth or on the feet, and there seemed to be

no doubt at all that the period of greatest infectivity followed immediately on the rupture of these vesicles. With respect to the disappearance of natural infectivity, their work at Pirbright had confirmed that of Lebailly, and of Vallée and Carré, showing that an animal is no longer infective after the lapse of about four days from the rupture of the vesicles. This, at least, appeared to be usual, but it could not be taken in any way as certain that all animals became non-infective in so short a time. Other workers had, in fact, produced some evidence of infectivity after a lapse of several weeks, but the methods employed had usually involved the inoculation of materials taken from the animals, and he was not aware that there were any experiments in which infectivity, after the lapse of many days, had been proved by actual contact with susceptible animals. He considered that, at present, there was no very convincing evidence of the existence of healthy carriers of the disease, but that one could not consider their possible occurrence to have been disproved.

A very considerable amount of work had been done at Pirbright on the question of disinfection. One of the most striking features of the results obtained had been the relative inefficiency of the carbolic acid series of disinfectants in relation to foot-and-mouth disease virus, although, in actual practice, the liberal use of these disinfectants appeared to give perfectly satisfactory results in the field. Practically any agent with an acid reaction was rapidly effective in destroying the virus, which appeared to be particularly sensitive to the quality of acidity. The salts of such metals as copper were shown to possess a high degree of efficiency in the destruction of the virus, but in actual practice their use must necessarily be restricted, and in many circumstances it would be impossible.

One of the main problems confronting those dealing with foot-and-mouth disease in England was to trace all the probable channels by which the disease might be introduced into the country, and, in this connection, the question of the survival of the virus under a variety of conditions was one of extreme importance. Low temperatures, of course, had a favourable influence on survival. The possible introduction of the disease in chilled or frozen meat was, naturally, a question of the highest importance to such a country as England. It had been thought that the acid reaction of muscle tissue in the carcass would be sufficient to prevent any introduction of the virus in such material, but it was important to determine whether the virus might not lurk uninjured in the various sites in which it might be protected from the action of muscle juice or any other body juices with an acid reaction. It had, in fact, been shown that in a frozen carcass the virus could persist in the bone marrow for at least seventy-six days, and it was by no means certain that that period was the longest possible under conditions favourable to the virus, and work on the subject was still in progress at Pirbright. There were various other possible sources of infection such as hides, and in a country such as Great Britain, which found it necessary to import really enormous quantities of animal products, it was no easy task to trace all the possible sources of infection. Even if these sources could actually be detected, it might also be difficult to remove the danger. There were other possibilities in connection with the introduction of the disease, and plant products could not be excluded from

consideration. For example, experimental work had shown that there was something connected with hay and bran that rendered them peculiarly favourable for the preservation of the virus, and living virus had been recovered from hay after periods of many weeks.

He referred briefly to the different methods of control of the disease, and mentioned particularly the plurality of types as an obstacle to the establishment of satisfactory methods of immunization.

Finally, he stated that no drug yet tried had given any promise at all of proving useful for treatment, and, in particular, that some of the claims that had been put forward in connection with iodine seemed to have been definitely disproved as far as the very susceptible cattle of Europe were concerned.