BIOLOGY OF EPIDEMICS*

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THE universe of study which to-day faces the epidemiologist is not, in its essence, composed of a number of cases of a clinically recognizable disease, with a distribution that varies in an observable way in space and time. It is composed of a variety of biological species, some acting as parasites and some as hosts. The parasites may be viruses, or bacteria, or protozoa, or worms. The hosts may be men, or animals, or insects, or plants. The parasite may pass from host to host by direct contact, by indirect mechanical contact, or through the agency of an insect vector. In whatever way it passes, the main factor that determines the occurrence and type of an epidemic prevalence is the frequency of its passage.

If all relevant environmental conditions are held constant, and susceptible hosts are added at a high and steady rate to an infected herd, a steady rate of mortality is attained, with no major waves or fluctuations. If, with a steady rate of addition, the closeness of contact between host and host is changed, increased closeness of contact is followed by the propagation of a major epidemic wave, and decreased opportunity for contact by a rapid fall in the mortality rate. These experimental observations have many analogies in the recorded prevalence of infectious disease under natural conditions.

During an epidemic prevalence the average resistance of the hosts rises with length of exposure to risk; in part because of the elimination by death of

the more susceptible individuals, in part because of the natural immunization of survivors. The resistance attained in this way, though sometimes high, is never absolute. We can, in many cases, attain the advantages of natural immunization, without its risks, by an appropriate method of vaccination.

Differences in severity between different epidemics of the same disease are in part accounted for by biological differences between various strains of a single parasitic species, between different races of a single species of host, or between different races of a single species of insect vector. The biological characters that determine the ability of a parasite to spread from host to host are not identical with the characters that determine its ability to multiply rapidly in the host's viruses, so that virulence and infectivity may vary independently.

In attempting to control epidemics we always strive, in one way or another, to decrease the probability of the passage of the causative parasite from an infected to a susceptible host. We may do this by changes in the distribution of the hosts at risk, or by lessening the population density of an essential insect vector, or by reducing the proportion of susceptible hosts by artificial immunization, or in many other ways. In no case is it necessary, by our own action, to reduce the probability to zero. The epidemic system is in unstable equilibrium. If we tip the balance far enough in favour of the host, the system itself will do the rest, and the disease will tend to become very infrequent, and may sometimes disappear.

* Substance of the Croonian Lecture delivered before the Royal Society on July 17.

LUMINESCENT MATERIALS*

FOR some years before the War there had been increasing interest in the fundamental and applied aspects of the luminescence of solids concurrently with a search for new and better luminescent solids by commercial firms. The possibilities in war of such materials are considerable; whilst it is obviously impossible now to discuss applications in the Services, there are many which can be made of value to the public at large. Unfortunately, at the outset of war, commercial development outran technical knowledge in the materials presented for sale to the public, and the consequent crop of failures aroused public prejudice against them.

The subject has been under investigation by a specially formed expert committee of the Civil Defence Research Committee, which has now issued a bulletin largely to explain how luminescent devices can best be used in present circumstances. The work of the Committee has covered both a comprehensive study of the theory of the subject including, in particular, the laws of phosphorescence; an attempt to make good the deficiencies in luminescent materials

and improve their method of manufacture; and an indication of possible applications. The bulletin in particular names the materials available and their properties, sources of irradiation, and enumerates a large number of possible applications, though the list is by no means exhaustive or complete.

The theory of the subject has been studied particularly by Dr. J. T. Randall at the University of Birmingham in recent years, where a method has been developed of studying the electronic 'traps' in luminescent solids. Such solids owe their properties to the presence of minute traces of an impurity, and their preparation depends on the addition of an activator to the pure matrix materials followed by a heat treatment which causes an intimate association of impurity atoms and matrix lattice.

The commoner luminous pigments fall into two main classes: (i) zinc and zinc cadmium sulphides; (ii) alkaline earth sulphides. The former have a high fluorescent brightness but relatively short periods of afterglow; the latter exhibit lower initial brightness but have longer periods of afterglow. To make these materials really useful in practice there must be uniformity in behaviour from batch to batch and, in the long run, their properties must be improved. In

* Luminescent Materials and their War-time Uses. Bulletin C.17, Ministry of Home Security, Research and Experiments Department, Princes Risborough, Bucks.