

SOME EMPIRICAL STUDIES IN EPIDEMIOLOGY

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1. Mathematical epidemiology

1.1. *Introduction.* The mathematical theory of epidemics has succeeded in producing a rather satisfactory account of the behavior, in large groups, of certain highly infectious diseases which confer a lasting immunity and have a low proportion of subclinical cases. Measles is the classical example but Professor Bartlett has argued convincingly for the same mechanism in some other acute fevers. These diseases are also characterized by an apparently high stability in the immunological structure of the causative organism.

At the other end of the scale, in small groups, it has been possible to give good accounts of the distribution of epidemic size in households or small communities. In particular, the mathematical concept of a threshold size above which the disease tends to affect the whole group and below which the epidemic peters out without affecting more than a fraction, fits in well with practical experience.

The mathematical theory of geographical spread of epidemics seems to me less well established, because of the lack of good observational data and the complexity of structure of even the simplest types of human community. In a subsequent paper Dr. Bailey [1] discusses the possibility of extending our knowledge in this direction.

1.2. *Problems which might be attacked by mathematical epidemiology.* It seems to me that it is worthwhile considering briefly some problems confronting the public health worker at the moment to whose solution mathematical epidemiology might make a valuable contribution. As I see it, the most important of these in highly developed countries with a temperate climate is presented by the acute viral infections of which influenza is the most important example. In the underdeveloped tropical countries a variety of viral bacterial and protozoal infections are of greater importance but good statistical data on them are very scarce. It is, though, worth noting that mathematical analysis has been found of value in the planning and assessment of malaria eradication campaigns when combined with adequate field work for the collection of basic data. The outstanding characteristics of the acute viral infections which any theory of their behavior must take into account are:

- (a) the great antigenic lability and diversity of the viruses;
- (b) frequently, the rather short period of immunity that follows an attack;