

THE EPIDEMIOLOGY OF FOWL CHOLERA

EXPERIMENTAL STUDIES

I. INTRODUCTION

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The following studies on experimental epidemiology carried out during the past few years have been concerned chiefly with the disease fowl cholera. A report of this work is presented in detail in the succeeding papers (1 a-d); in this introduction, a brief statement will be made of the purpose and scope of the work, the methods employed, and results and conclusions obtained.

The investigation was undertaken primarily to determine whether bacterial infections in general spread according to one and the same type of mechanism. It had been found that in communities of mice or rabbits in which certain intestinal and respiratory infections prevail, epidemics occur in response to a characteristic sequence of events, disturbing the balance between the resistance of the community and the quantity of available microbes (1 e). The steps in the evolution of such epidemics appear to be as follows: first, some influence can be demonstrated in these communities which operates to decrease the resistance factor. A *fall in resistance* causes a reciprocal rise in the number of carrier individuals and in the amount of infectious material available. This *increase in the dosage* factor is followed by the epidemic outbreak. No significant enhancement in the virulence of the microbes is demonstrable. So consistent are these findings that their further operation was tested by similar studies of another animal disease.

Fowl cholera was chosen for study because it is regarded as a classical example of an epidemic disease. Its characteristics are well-recognized.

The disease occurs, according to Manninger (2), wherever poultry are raised in any great number. It is said to assume two forms: one, explosive, acute, and highly fatal, in communities hitherto unexposed; the other, a mild, endemic form attended by occasional, rather severe outbreaks. *P. avicida* is believed to exist both in a saprophytic form of low virulence and as a highly virulent parasite in the tissues of an occasional "carrier" fowl (2). The portal of entry is believed by field observers to be the gastrointestinal tract, although attempts to induce the disease experimentally by feeding have commonly failed (3). The lesions found in fowls dying of the acute form of disease are not extensive. They consist of sero-fibrinous exudate in the pericardial sac, subserous petechial hemorrhages in the pericardium and intestine, and congestion and sero-fibrinous exudate in the lungs. When the affected fowl survives longer, one finds fibrinous pneumonia and necrotic foci in the liver. In the chronic disease, caseous pneumonia, pulmonary abscesses, periartritic, subcutaneous, and intramuscular abscesses are encountered. Moreover, localized lesions, such as edema of the wattle and some forms of nasal, sinus, and ocular roup have been considered manifestations of fowl cholera (4). *P. avicida* is known to possess definite characteristics common to the Pasteurella group. But the serological relationships of cultures from different sources and of Pasteurella organisms of other animals are poorly understood.

These facts summarize what is known of the epidemiology of fowl cholera. The present studies were designed to gain a more complete understanding of its mode of spread. For this undertaking, three general methods of investigation were employed: A) bacteriological and pathological tests; B) field observations, and C) studies of epidemics experimentally induced in poultry flocks. Each was applied to a definite phase of the general problem. The bacteriological and pathological tests were made to determine 1) the characteristics of strains of Pasteurella obtained from typical fresh cases of the disease, 2) the relation of these strains to the so-called "surface," "saprophytic" forms of the organism, 3) the portal of entry into the fowl, and 4) the varieties of host response to these microbes. A field study of the spontaneous disease in poultry flocks was undertaken to ascertain 1) the amount and character of the infection, 2) monthly fluctuations in its prevalence, 3) relation of *P. avicida* nasal carrier rate to spread of the disease, 4) the significance of different strains of *P. avicida*, and 5) differences in response of individual birds to the infection. An experimental study of fowl cholera epidemics is being made under controlled conditions whereby communities of healthy fowl are established and strains of *P. avicida* introduced, a technique permitting

direct determination and measurement of the factors concerned in the rise and fall of epidemic outbreaks.

The results of A) the special studies of *P. avicida* are presented in the following paper by T. P. Hughes (1 a); a preliminary report has already been issued (1 f). The findings are as follows: 209 strains of *P. avicida* from fresh cases of fowl cholera arising on widely separated poultry farms proved to be closely identical in cultural and serological behavior. On the basis of colony formation, however, three groupings were made: "fluorescent," "blue," and "intermediate" types. The "fluorescent" form, stable in suspension, with low, narrow zone of agglutination in acid buffers (pH 2.4–3.0), was found only in association with severe epidemics, and was relatively highly virulent and non-vegetative. The "blue" colony type, unstable in suspension, with wide zone of acid agglutination (pH 2.4–5.0), was found to be commonly associated with endemic cholera and was of relatively low virulence and high vegetative capacity. The "blue" colony type was obtained also *in vitro* from cultures of "fluorescent" type organisms grown under unfavorable conditions. The third colony type, designated "intermediate," proved somewhat stable in suspension, usually with a wide acid agglutination zone, and was "intermediate" in virulence and vegetative capacity. This variety was found in communities in which severe epidemics existed. Apparently the fluorescent colony form can be transformed into a blue colony type which may or may not be identical with the "blue" colony types found in communities where fowl cholera is endemic. Attempts to change "blue" colony types to "fluorescent" have been unsuccessful. The limit of variability of the "intermediate" colony type has not been determined. Under some conditions it resembles the "fluorescent" form; under others, the "blue," and yet attempts to effect a permanent transformation have not succeeded. The serological uniformity of *P. avicida* indicated by these studies may be apparent rather than real. Possibly, specific substances, undetected and not measurable, are present.

The results of special studies on portal of entry of *P. avicida* and host reaction to these organisms are presented in paper III by T. P. Hughes and I. W. Prichett (1 b), and in the preliminary report (1 f). They point out that fowl cholera is to be regarded as a respiratory infection which manifests itself in various ways by bringing about a)

a "carrier" state in the nasal passages of healthy individuals, b) an involvement of sinuses and nasal passages in others, as well as c) the typical manifestation of the acute septicemic process.

The results of B) field studies of the spontaneous disease in poultry flocks are contained in papers IV and V by I. W. Pritchett, F. R. Beaudette, and T. P. Hughes (1 c, d.) The findings differed according to whether the infection had been endemic in the flock for some time, or introduced relatively recently. The infection, when present in endemic form, varied with the season, increasing in amount and severity during the autumn months to a winter maximum, and then declining during the summer season to a minimum. Furthermore, its prevalence and tendency to spread varied with the number of nasal carriers: a decrease in carrier rate being accompanied by a decrease in disease mortality and in the occurrence of the local infections, roup, catarrh, and edema of the wattle. In these communities, the "blue" colony type of *P. avicida* was recovered. The virulence of strains from fatal septicemic cases, from local lesions of survivors, and from the nasal clefts of healthy carriers, was similar and relatively low. *P. avicida* infection in flocks of poultry with no history of previous cholera assumed the form of severe epidemics. The outbreaks arose during the winter months. The daily death rates were high; post-epidemic carriers among the survivors were uncommon. Following an epidemic, the infection tended to die out. The strains of *P. avicida* recovered were of both the "fluorescent" and "intermediate" colony types and of high virulence.

C) The observations on "experimental" epidemics of cholera are still in progress and are withheld for further consideration.

The studies so far carried out indicate that the epidemiology of fowl cholera rests upon essentially the same basis as that of rabbit pasteurellosis (1 e). In each instance, the severe epidemic form of infection is associated with a relatively virulent type of organism which survives with difficulty in the tissues of the host, whereas the endemic disease is associated with strains of relatively low virulence and high vegetative capacity. In fowl cholera, as in other animal diseases studied (1 e), the spread and severity of infection appear to be controlled by the resistance of the host and the dosage of the organisms.

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