The History of Avian Medicine in the U.S.
II. Pullorum Disease and Fowl Typhoid

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Pullorum disease was first recognized in 1899 (in Indiana, by Dr. Leo F. Rettger, later at Yale University). Identification of the causal agent, ultimately named *Salmonella pullorum*, opened avenues of investigation with far-reaching effects. This discovery of the cause of major mortality in poultry flocks was an important factor in the development of the poultry industry.

The development of the avian pathologist was a by-product of research work on pullorum disease during the first few decades following Rettger's finding. The lives of many people were vitally affected. Control of the disease made intensive poultry production possible, profoundly benefiting man through the high-quality proteins so efficiently produced by chickens and turkeys.

The disease was first called a "fatal septicemia of young chicks." That was soon changed to "bacillary white diarrhea," shortened by many to BWD. The term "white diarrhea," also used for this and other diseases of poultry, caused much confusion in understanding chick diseases of those times. At the second Northeast Conference on Pullorum Disease, in 1929, the term pullorum disease was adopted. The name became internationally accepted following a recommendation by the United States Livestock Sanitary Association at its 1929 meeting.

Scattered reports in the lay press indicate that the disease was widespread in the U.S. and elsewhere, and that it was a serious economic problem. Early investigations were carried out largely by Dr. Rettger and his associates and students. In 1909, transmission of this infection through the egg was reported by Drs. Rettger and Stoneburn, representing the first report of egg transmission of any infectious disease. It was not until 1914 that Dr. Rettger and co-workers established the complete cycle of infection and proof that infected chicks could become permanent carriers capable of laying infected eggs. With the advent of commercial hatching, incubator transmission became the most important source of spread of the disease.

The foundation of the diagnostic procedures now in use was the development of the macroscopic tube agglutination test for the detection of infected birds, in 1913, by Dr. F. S. Jones of Cornell University. This test was quickly adopted, particularly in the New England States, and routine testing on a statewide basis was soon inaugurated, as, for instance, in Massachusetts in 1915. Rettger and co-workers reported in 1914 the testing of 107 flocks representing 14,617 birds and finding 9.8% reactors. Testing programs expanded rapidly into other states during the next few years. Many flocks were found free of infection on initial test. It was learned that more than a single test in a flock was often necessary to detect and remove all infected individuals. Infected flocks could either be retested or be replaced by stock from known free flocks. During much of the period while testing programs were being established, the industry was of such nature that testing was done in the fall and winter, leaving the remainder of the year for research or other activities.

Dr. F. R. Beaudette, of New Jersey, in a commemoration of the fortieth anniversary of the discovery of *S. pullorum,* noted that the testing programs contributed to expanded work in the avian pathology field — "so we find here and there persons giving much time to the study of poultry diseases. Invariably the investigators started with 'bacillary white diarrhea,' and easily confirmed all that had been reported. . . . The investigator was then apt to branch out on some other disease. . . It seems to me that in this way the full time poultry pathologist really originated." That was particularly true in laboratories of agricultural colleges. Beaudette stated further that pullorum disease "was, and still is, one of the few animal diseases for which absolute preventive measures were developed." And, further, "the chicken is a superior experimental animal . . . for it is the one animal that can be produced, with few exceptions, free of diseases that in mammals are contracted while in utero or by the necessary cohabitation with the mother during early life . . . and whereas, a hundred chickens are carefully examined to one larger animal, it requires no imagination to predict that one's knowledge of the disease of this species will exceed that of all others."

Many problems arose in the establishment of eradication programs, such as doubtful reactions in serums from birds in known pullorum-free flocks, finding the most suitable test fluids, proper

dilution thereof, and the maintenance of reliability of testing. In 1928, Drs. W. R. Hinshaw, J. B. Lentz, L. F. Rettger, and others in New England organized the first annual meeting of Laboratory Workers in Pullorum Disease Eradication. That may well represent also the first such meeting of avian pathologists in the U.S. Among the organizers, Hinshaw, at least, had had experience, although at Kansas State College, through participation in a standardization conference held in 1925 in the northeast, at which a uniform plan of accreditation and certification of poultry was adopted. That conference became what is now known as the Northeast Conference on Avian Diseases. Workers from all the New England States were in attendance. That year, 510,549 tests had been made in 861 flocks, of which 398 were considered free of infection. Lists of flocks known to be free of infection had been available for some time.

During the next few years, particular attention was given to selecting the best strains of the causal organism for antigen preparation, details of methods of preparing antigen, conducting the tests, and interpreting the results. An important feature of early conferences was a direct comparison of antigens prepared by individual laboratories when tested with serums of various agglutinating strengths and of interpretation of tests by participants. That led to the submission of samples to the antigen committee early enough for comparative tests before the annual meetings. The testing was done at the Massachusetts laboratory, first under the direction of Dr. H. Van Roekel and later under Dr. G. H. Snoeyenbos. Recently, testing has been reduced to alternate years. After study and use of other strains of *S. pullorum* for a few years, there was a return to the cultures originally provided by Dr. Rettger. That proved to be a very good choice, for the strains are still in use. The third annual meeting had expanded to include 14 Northeastern States and three laboratories in Canada.

Dr. Hinshaw, then still in Kansas, and associates reported in 1926 on the transmission of pullorum disease in incubators. The introduction of forced-draft incubators, particularly the larger ones, was of importance in the dissemination of pullorum since the infection spread rapidly from infected to uninfected newly hatched chicks. In New England, early in this period, each breeder usually had his own incubator(s), and experienced no spread of infection from or to other farms, since in most instances these flocks were

free of the disease. There was more of a tendency in the Midwest for smaller flock owners to secure chicks from commercial hatcheries using larger incubators and securing hatching eggs from many flocks, of which some were often infected. Following an initial report by Dr. Bushnell and colleagues, in Kansas, that fumigation with formaldehyde gas was effective, much research work was devoted to developing methods of fumigating eggs, incubators, and newly hatched chicks, particularly at Kansas and Kentucky and among incubator manufacturers. Various methods and times of introducing the formaldehyde gas were developed and tested, and other fumigants were also tried. Incubator sanitation was greatly improved in the process.

A rapid serum-agglutination test was reported in 1927, by Dr. R. A. Runnells and co-workers in Virginia. This test did not find wide application, however. In 1929, Drs. Hebert Bunyea, Walter J. Hall, and M. Dorset of the USDA reported on a test using whole blood. The original test fluid consisted of a living culture serving as an antigen. This was soon marketed but proved ineffective. In 1931, the above workers and others at the USDA and Drs. D. R. Coburn and H. J. Stafseth independently at Michigan State College, described the stained-antigen whole-blood test. This test formed a basis for a rapid expansion of testing and elimination of infection, particularly in larger states, where transport of blood samples to central laboratories was less convenient. The whole-blood test is credited with doing more than anything else to improve the quality of chicks in the Midwest and South. Economic conditions also played a large part; for example, it was not easy to convince an Iowa poultry producer to pay five cents or so for each test on breeders for the production of meat birds which might be expected to sell for fifteen cents when they reached three pounds.

The economic importance of the eradication of pullorum disease is not easy to assess. Early reports of mortality among chicks ranged up to 85% and higher. At the close of the nineteenth century, this malady was considered a very serious menace to the poultry industry. In the first quarter of the twentieth century it was still considered the most important disease of poultry. Frank D. Reed, extension poultry specialist in Maine, has stated that before World War I, an individual with 100 or more chickens was considered to be quite heavily in the "chicken business." As the

poultry industry expanded, particularly with the introduction of forced-draft incubators, pullorum disease menaced the poultry hatching industry. Egg production, fertility, and hatchability have all been documented as specifically reduced by this disease. Some survivors of an outbreak show retarded growth. Certainly the losses of "hundreds of thousands of dollars every year," estimated in 1939 by Dr. Morley A. Jull of the Poultry Department of the University of Maryland, are not exaggerated. Testing has proved fairly expensive but has resulted in untold benefits. During the time when eradication programs were progressing, it was possible for a breeder to command a higher price for stock known to be free of pullorum disease. The availability of such stock was one of the principal reasons for the development of the broiler industry. That was particularly true in the thirties, when the northeastern states were a major source of such stock. Pullorum-disease-free hatching eggs and chicks are currently demanded by all buyers.

In 1933, Standard Methods of Diagnosis of Pullorum Disease in Barnyard Fowl were presented by members of the Conference of Research Workers of the U.S. and were adopted by the USLSA, later called the U. S. Animal Health Association.

In 1935, a National Poultry Improvement Plan (NPIP) was adopted. This was a team approach to upgrade breed quality, on one hand, and control pullorum disease, on the other. Different areas of the country differed in their aims: The East and Pacific Northwest were particularly interested in recognizing and maintaining flocks free of pullorum infection, whereas the Midwest was interested in reducing the levels of infection in individual flocks. The NPIP recognized three methods of testing. The whole-blood test was widely adopted in the Midwest, and its widespread use there gave great impetus to an eradication program. The tube agglutination test continued in use in the Northeast, and the rapid serum test found use particularly in testing turkeys.

Many of the problems of pullorum control were settled in the Northeastern states and the Pacific Northwest. At that time the industry in the Midwest had not completely emerged from the farm-flock stage, cared for by the housewife. When she bought chicks, she expected to lose twenty to fifty percent, and frequently lost more. She was a little slow to demand chicks free of pullorum disease. The term "pullorum-tested" confused inexperienced buyers

into thinking that meant pullorum-clean. The former classification, commonly used in the Midwest in the early years of testing, almost guaranteed infection. If there was no infection, the flock would be officially classified as pullorum-clean or pullorum-passed.

The very closely related disease fowl typhoid, caused by *S. gallinarum,* was recognized in 1888 and on other occasions before Rettger made his pullorum discovery. These two diseases, so much alike, had quite different impacts on science and the poultry industry. Fowl typhoid is generally an acute disease in young adults, whereas the more dramatic manifestation of pullorum is mortality in young chicks. Observations over the years, however, revealed an acute manifestation in young adults with the pullorum organism, and a high mortality in chicks with fowl typhoid. Fowl typhoid frequently seemed to reveal seasonal tendencies, although involving different seasons in different areas of the country. It was early realized that some breeds of chickens, especially the White Leghorn, were more resistant to pullorum disease. That may account for somewhat less interest in testing for pullorum disease in states where this breed predominated (e.g., New York and California). Attempts to breed for resistance to fowl typhoid perhaps drew more attention, though there were many who thought that breeding for resistance to pullorum infection might be the answer to control. The high incidence of pullorum-free flocks in some areas partially explained the low incidence of fowl typhoid, since both diseases are detected by the same test. In 1954, nineteen years after the inception of the National Poultry Improvement Plan, it was revised to recognize flocks free of fowl typhoid as well as pullorum disease.

In 1930 Plastridge and Rettger reported an acute outbreak of pullorum disease from which a pleomorphic organism was isolated. Henry Van Roekel, of Massachusetts, studied pleomorphism extensively, at first as a student in Rettger's laboratory. In 1941, Younie, in Ontario, reported on an *S. pullorum* variant which was later found to be fairly widespread. It threatened to disrupt the agglutination testing program since the variant had a slightly different balance of antigens. Some antigens used in the whole-blood test were modified as to strain content to cope with the new problem. Laboratories in the Northeast Conference of Laboratory Workers in Pullorum Disease Eradication did not modify their test procedures since infection was apparently being reliably identified with the standard antigen in the tube test.

Chickens appear to be the natural host for pullorum disease. Significant infection was introduced also into commercial turkey flocks in the 1930's through commingling, especially of eggs in forced-draft incubators. A National Turkey Improvement Plan was established in 1943. The whole-blood test, used so widely in chickens, was not dependable in turkeys. Even so, the infection was eliminated from commercial flocks fairly promptly, partly because the greater value of the individual bird allowed more intensive control efforts and partly because *S. pullorum* is less well host-adapted to the turkey. There have been reports of infection in many species of birds, some of economic significance, but most cases could be traced to some contact with chickens. Infection has been identified in mammals, with rabbits especially susceptible. A theory long held by Rettger that *S. pullorum* might infect humans was proved to be true before his death, in 1954. Several reports of mild digestive disturbances have been associated with *S. pullorum* infection. Hinshaw (personal communication) reports a human case which was probably of laboratory origin.

Bacterins for fowl typhoid were commercially available for a number of years, though their efficacy has never been fully established. A wide variety of chemicals and drugs were tried before the second World War, but without success. Then, when antibiotics, sulfonamides, and nitrofurans became available and tested, with many proving effective, a revolution in control was in the making. This proved particularly true with fowl typhoid, when it became of importance to control an acute outbreak in adult fowl. These compounds, while effective in reducing mortality, did not eliminate infection from a flock. The current requirements of the NPIP of including fowl typhoid in its testing program has helped to designate fowl-typhoid-free flocks and aid in its control.

S. pullorum continues to require vigilance for successful poultry rearing because eradication efforts have been directed mostly toward flocks of economic importance. There remains a reservoir of infection in small backyard flocks and in small flocks maintained for the production of show birds. When the NPIP was inaugurated in 34 states, in 1935, involving 1017 hatcheries, over four million birds were tested, with 3.7% reactors (160,187 affected breeding birds). By 1948, 47 states were involved, including 2,354 hatcheries, with over 30 million birds tested, revealing 1.8% reactors. In 1975, NPIP found no evidence of infection

in commercial poultry. Only 51 cases of pullorum disease were reported, including one in ducks, one in pheasants, and 49 in non-commercial chickens. Indeed, large regiments of the poultry flocks of the country have been free of infection for many years, and that is recognized by the NPIP through the relaxation of regulations in the late 1960's, considering a flock to be pullorum-free through annual testing of only 25% of birds in flocks supplying eggs to a hatchery. This type of regulation was further modified in 1975 by allowing further reduction in the number of birds in flocks that are maintained under certain conditions and have repeatedly been found free of infection.

As Dr. Philip R. Edwards stated at a National conference on salmonellosis in 1964, pullorum disease could well be cited as an example of the control which can be achieved in a host-adapted type through thorough study of its ecology and methods of transmission and exercise of measures to restrict its spread. No other major livestock disease has been brought under control by the industry itself without benefit of federal regulations or federal funding.

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