Animal Diseases and Human Health

On September 11–13, 1957, a Conference on Animal Diseases and Human Health was held in New York City under the joint auspices of the New York Academy of Sciences and the Public Health Service's Communicable Disease Center.

The significance of these diseases was discussed from two viewpoints: the direct transfer of disease by parasites or by consumption of diseased meat and milk, and the reduction of food supplies caused by outbreaks of animal disease.

Enzootic, epizootic, and zoonotic diseases were considered, along with means by which the diseases are transmitted. Some were examined because they present particular economic and public health threats; others because the study of animal diseases may enlighten students of human afflictions.

The conference discussions are represented here in summaries of 16 of the papers. The full proceedings are to be published by the New York Academy of Sciences.

Salmonellosis: Incidence and Control

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It is impossible to determine the incidence of salmonellosis in either man or animals. No systematic method of reporting salmonellosis of animals has been established, and one must rely on summaries of isolation and identification of causative agents dispersed throughout the medical and veterinary literature to estimate the frequency with which the bacteria occur among the lower animals.

Means of determining the incidence of the disease in man are practically in the same condition. Summaries published by the National Office of Vital Statistics are based on woefully inadequate reporting from a minority of States, and in most instances the etiological agents of foodborne infections are not accurately determined. Despite these deficiencies, one must rely upon these summaries for any estimate of the prevalence of *Salmonella* infections in the United States.

Despite methodological inadequacies with regard to incidence, the list of occurrences indicates that there is a direct correlation between salmonellosis of animals and man in any given locality, although the methods whereby the organisms are transmitted from animals to man and vice versa may vary from one region to another, depending upon sanitary facilities and habits of the population.

Numerous *Salmonella* serotypes have been isolated from animals used as food by man and from animals with which man comes into close contact. Not only have host-adapted types such as *Salmonella dublin* in cattle and *Salmonella choleraesuis* in swine been found frequently, but large numbers of types not adapted to specific hosts occur among domestic animals. While salmonellae are particularly numerous in swine, birds probably constitute the largest single reservoir in animals. The organisms have been isolated from turkeys, poultry, wild game, and egg products. Among the nonedible

animals and insects in man's environment, dogs, cats, rodents, flies, ticks, snakes, and tortoises have been incriminated as vectors of salmonellosis. Salmonellae have also been isolated from fish and shellfish, and the evidence indicates that these species encountered the organisms in water contaminated by man or other nonaquatic animals.

Since *Salmonella* types are widely distributed through the animal kingdom, there is small wonder that the organisms are frequently present in animal food products. Recent investigations have revealed their presence in an unexpectedly high percentage of meat and animal products, and this has resulted in a further investigation of the roles that food processing and human carriers have in salmonellosis. Carcasses in abattoirs have been shown to contain organisms more often than animals on farms, indicating that the abattoir environment and processing procedures favor the spread of the organisms. Investigators have also found salmonellae widely distributed in poultry-processing plants.

Although outbreaks in which human carriers were responsible for the contamination of meat products have been frequently described, the ultimate source is in no way certain since it might be said that the carrier state is an occupational hazard of those who continually handle uncooked meats and carcasses. Direct transmission may also occur from man to man without the intervention of food.

Means for control of the incidence and transmission of salmonellosis are slowly getting under way.

While there is a large reservoir of salmonellae in the lower animals, this situation can be expected to improve gradually. Tests for the detection of the infections and methods of eradication are being studied in fowl and cattle. Progress has been made in the eradication of salmonellae from poultry flocks through agglutination testing programs for *Salmonella typhimurium*. Possibilities of detecting *S. dublin* infection by agglutination tests have also been studied. Although the elimination of salmonellosis from flocks and herds cannot be accomplished in the immediate future, it is encouraging that animal pathologists are thinking of eradicating the infections rather than controlling them. It must be admitted, however, that this attitude is directed largely by economic considerations rather than by regard for public health.

In any effort to eradicate salmonellae from domestic animals it is necessary to take into consideration the continuous seeding of the population through infected feed, and such sources must be eliminated if *Salmonella* infections are to be eradicated from flocks and herds.

With regard to dissemination from person to person, every effort should be made to prevent the spread of organisms among the population by means of the excreta of patients, convalescents, and carriers. This is a joint responsibility of the practicing physician, the health officer, and the laboratory. Prompt isolation of patients with symptoms of intestinal infections and proper disinfection of the dejecta must be carried out until such time as a definite diagnosis is established. Contacts should be examined bacteriologically, and the strictest personal hygiene should be practiced in the household. Convalescents should be examined systematically until the bacteria no longer can be isolated from the excreta.

Stool cultures should be required from all food handlers, not only those in food dispensing establishments but those in food processing plants as well. In addition, hygienic conditions in these plants and establishments must be improved. It has been demonstrated that thorough and consistent cleansing of abattoirs and equipment results in a marked reduction in the recovery of salmonellae from carcasses and from the environment.

Researchers have suggested that bacteriological standards for the control of abattoir and food processing establishments would be helpful; that an approach similar to that employed in dairy products should be applied to other products of animal origin including fish and poultry; and that, in time, coliform organisms as an index to pollution may be successfully adopted for the bacteriological environment of meat processing plants as it has been adopted successfully in dairy products and shellfish.

Food technology has made giant strides within recent years, especially in the removal of food preparation from the family kitchen to

the large establishment. It seems in many instances that methods of control and measures for their enforcement have not kept pace with advances in food processing. More rigid control of products becomes even more important and practical when it is remembered that salmonellae may survive temperatures to which food products are sometimes subjected in cooking. Since it is possible to pasteurize certain food products effectively or to destroy salmonellae in them through a combination of acidification and mild heating, it would not seem unreasonable to adopt and enforce bacteriological standards for such products. New processes of food preparation and storage require new and improved procedures and practices to deal with them.

All of the writers who have given serious thought to the control of salmonellosis agree that effective control can result only through the cooperation of governmental agencies dealing with health, agriculture, and food. Further, it is agreed that salmonellosis should be a reportable disease of both man and animals, and that effective reporting and control measures should be enforced.

Through cooperation of physicians, health officers, veterinarians, and sanitarians with the proper governmental agencies, and through education of the public in the fundamental sanitary aspects of the preparation and preservation of foods, control of the infections may be expedited.

Newcastle Disease

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Newcastle disease is a minor occupational disease limited chiefly to persons working with chickens and eggs and to those concerned with control of the disease. The population at risk is rather sizable since poultry is raised on approximately 3,418,000 farms in the United States.

In all known instances, infection of man has been limited to the initial case, the transmission being from bird to man and never from man to man. Acute conjunctivitis is the usual manifestation, although systemic disease has been reported. Initial diagnosis of Newcastle disease in man is dependent mainly upon isolation of the virus, for the serology is complicated by certain problems of interpretation.

The importance of Newcastle disease lies in the resulting higher-priced poultry products and a reduction in their quality. The disease may kill, but more often it affects the poultry by interrupting growth and egg production, and it increases the percent of birds and eggs rejected for abnormalities.

While vaccination has permitted profitable production of poultry, it has not eliminated the virus in any part of the Nation, and it has not reduced the hazard of human infection. An organized control and eradication program is lacking, and without one the virus is afforded infinite opportunity to give rise to a mutant capable of maintaining itself in the human population.

Pulmonary Adenomatosis in Sheep

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Workers in various parts of the world have described several invariably fatal pulmonary diseases of sheep that can probably be grouped together into a complex of related entities.

Histologically, these diseases can be arranged in a spectrum, with pure infiltrative pneumonia or pulmonary lymphomatosis at one end, and metastasizing adenocarcinoma at the other. All degrees and combinations of inflammatory neoplastic disease occur between the two extremes, some forms being histologically indistinguishable from human pulmonary adenoma.

Representatives of all forms are naturally contagious, including the metastasizing adenocarcinoma of Peru, and there is considerable evidence that all forms in sheep are naturally transmissible. Experiments now under way with an infiltrative form occurring in Montana

indicate that transmission can be effected by inoculation of sheep with sterile centrifuged extracts of infected and frozen sheep lung. Although 1 to 3 years are usually required from the time of inoculation until symptoms appear, the disease develops progressively. Sheep sacrificed periodically after inoculation show pathological changes at least several months before symptoms are expected to appear.

Apparently pulmonary adenomatosis in sheep was entirely enzootic until early in the present century when epizootic disease appeared, inviting recognition of its contagious nature. Forms of pulmonary adenomatosis of similar histology and clinical course also occur in man. Whether etiological similarities obtain is an unanswered question at present. Information gained from the study of contagious animal neoplasm, however, may be useful as a guide to the future study of neoplasia in man.

Cat Scratch Disease

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The specific entity known as cat scratch disease, cat-bite fever, benign inoculation lymphoreticulosis, nonbacterial regional lymphadenitis, and so on, has been recognized as a common human disease only during the past decade. Actually, the condition was recognized as early as 1930 by Foshay in Cincinnati, Ohio, but published detailed descriptions did not appear until 1950.

Most cases of cat scratch disease follow scratches or bites by domestic cats. But other sources have also been recognized, including thorns, cat urine, and bone spicules. No definite clinical disease in the offending animals has been discovered.

Lymphadenopathy is the most characteristic lesion of cat scratch disease. Usually the nodes draining the area of the primary lesion are involved, but extension to other parts of the body may also occur. Thus the axillary and epitrochlear nodes are most commonly involved in scratches or bites on the hand and forearm, the inguinal nodes with lower limb lesions, and submandibular, suprascapular and cervical nodes following scratches about the face, neck, and chest.

In addition to the typical picture of regional lymphadenopathy, syndromes involving bone, central nervous system, eyes, and the spleen have been observed.

Geographically, the disease is widespread, having been reported in Europe, Great Britain, North and South America, and Asia. Undoubtedly many cases occur that are as yet unrecognized.

The causal agent has never been identified. It has been presumed that an agent similar to those of the psittacosis-lymphogranuloma venereum group is responsible, but recent information does not tend to confirm this presumption.

Extensive microbiological and pathological studies have been done and, although no proven etiological agent has been discovered, characteristic histological lesions have been described. There is no specific skin test that is quite accurate in diagnosis.

There are no public health methods presently applied for the control or treatment of this disease. As the association of man with domestic pets continues, increasing numbers of clinical cases are likely.

The Pan American Zoonoses Center

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The Pan American Zoonoses Center is an international institution dedicated to promoting and strengthening activities against the zoonoses in the Americas. Its services are available to health departments, agriculture departments, educational institutions, and other agencies interested in the zoonoses: those diseases naturally transmitted between animals and man.

The center, which has its central site in Azul, Province of Buenos Aires, Argentina, was established in August 1957. The Pan American Sanitary Bureau is the sponsoring international organization, although provisions have been made for other international agencies to

Main building of the Pan American Zoonoses Center in Azul, Province of Buenos Aires, Argentina. The only international institution of its kind, the center is primarily devoted to research on diseases communicated from animals to man. The center was established in August 1957 as a result of a special agreement the previous year between the government of Argentina and the Pan American Sanitary Bureau, Regional Office for the Americas of the World Health Organization.

join forces with the Bureau. Provisions have also been made for direct support of the center through contributions from any country.

The center is designed to educate and train professional and paraprofessional personnel in techniques and methods to combat the zoonoses. It will also (*a*) conduct research to improve diagnosis, epizootiological-epidemiological knowledge, and control procedures; (*b*) promote, aid, and coordinate such research in government and private institutions; (*c*) work toward the standardization of diagnostic methods for making and testing vaccines, serums, antigens, and other biological products; (*d*) prepare and disseminate information on the zoonotic diseases; and (*e*) develop field demonstration activities in accordance with the needs of participating countries.

Promoting and strengthening governmental activities against the zoonoses in the Americas is the principal function of the center. But this objective can be reached only insofar as there are sound technical activities and services in each country dedicated to research, control, and eradication of diseases common to man and animals.

While there are over 80 zoonoses, the center will give priority to those of major importance in the Americas: rabies, brucellosis, hydatidosis, tuberculosis, encephalitis, salmonellosis, psittacosis, and anthrax.

Leptospirosis in Man

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Human leptospiral infections comprise a multiplicity of separate syndromes whose clinical features vary from mild grippe-like illnesses to those simulating fulminant hepatitis or "aseptic meningitis." The classical disease, described by Weil in 1886, is caused by *Leptospira icterohemorrhagiae* and is recognized clinically by the development of fever, icterus, conjunctival injection, myalgia, hemorrhagic

tendency, renal, hepatic, and vascular failure, and a high fatality rate. Symptoms persist from 1 to 3 weeks. Leptospiremia and leptospirura occur at various stages and antibodies are demonstrable in convalescence.

The currently recognized human American species of *Leptospira* are *icterohemorrhagiae*, *canicola*, *pomona*, *bataviae*, and *autumnalis*.

Milder forms of illness result usually from infection by leptospirae other than *L. icterohemorrhagiae* and *L. bataviae*. Over 200 patients with leptospirosis contracted in a tropical environment had fevers enduring from 4 to 20 days, with an average of 8 days. Studies conducted in Malaya from 1954 to 1955 revealed leptospiral infections to be a significant cause of short-term pyrexia. Only two fatalities occurred among these patients and few presented overt clinical evidence of hepatic, renal, or cardiovascular insufficiency.

Clinical features may resemble aseptic meningitis. A leptospiral etiology should be considered in any illness characterized by fever, myalgia, nausea or vomiting, conjunctival injection, proteinuria and neutrophilia.

Rheumatoid Arthritis in Man and Arthritis in Swine

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Arthritis in swine is prevalent under farm conditions. In some cases, an infectious agent can be isolated; in others, none can be found. Pyogenic bacterial infections produce enlarged, soft joints distended with pus. This purulent type of infection occurs most frequently at the time of birth, probably through the umbilicus.

In *Erysipelothrix rhusiopathiae* infections, the organism may disappear from the joints while the arthritis persists. In such cases many macroscopic and microscopic pathological changes similar to rheumatoid arthritis in man are present.

In acute arthritis there is synovitis, characterized by vascular engorgement, and edema of the synovial tissues. The effusion is turbid or serosanguineous and mucinous. The synovial villi show evidences of beginning proliferation and beginning lymphocytic infiltration. Later, greater proliferation and less edema are observed. Proliferation of the mesothelial cells covering the hypertrophied synovial villi is present. The villi contain young, highly vascular connective tissue, plasma cells, and lymphocytes. A striking feature is the accumulation of dense collections of lymphoid cells resembling germinal centers of lymphoid tissue.

In advanced chronic arthritis with pannus formation of subchondral origin, fibrosis in the adjacent narrow spaces, increased vascularity, and collections of lymphocytes occur. Pannus formation over the articular cartilage with or without fibrous ankylosis, narrowing of the joint spaces with rarefaction of the adjacent bones, and greatly thickened capsules are evident.

A comparison of arthritis of swine and rheumatoid arthritis of man shows some similarities. In both diseases, the changes are essentially proliferative and nonsuppurative and have a tendency toward granulomatous proliferation in the synovial membrane. Pannus formation and focal accumulations of lymphocytes are observed. Destruction of cartilage at the site of pannus attachment and subchondral cellular reactions appear similar. Rarefaction of the bone as revealed by radiography and intra-articular fibrous adhesions are common to both diseases.

Listeriosis: A Public Health Problem

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Listeriosis is a little known, infrequently recognized, but widespread bacterial disease of man and other warm-blooded creatures. The causative agent, *Listeria monocytogenes*, has been recovered from man, mammals, and birds in a number of countries all over the world, and in 22 of the 48 States.

Morphologically, the organism is a gram positive, non-acid-fast, non-spore-forming rod.

There is a tendency for the organisms to arrange themselves into "V's" or into a palisade formation when the smear is made from solid media. The bacteria stain evenly and are 0.5 to 0.6 by 1.0 to 2.0 microns in size. Short, but sometimes long, threadlike chains may be observed in the rough phase of growth. Capsules are not demonstrable. Motility can be demonstrated in 6-hour glucose broth cultures, but it is more pronounced at 25° C. after 24 hours incubation. The peritrichously flagellated organisms have a characteristic tumbling motion.

Listeria frequently fails to grow when cultured from fresh tissues, but it has been found that refrigeration of the original necropsy specimens and periodic subculturing will increase the number of isolations obtained. There are four serotypes of *Listeria*, and among these are several biotypes. All serotypes and biotypes can and do attack man, poultry, and mammals.

The specificity of agglutinating titers is open to question since some serums spontaneously agglutinate antigen, and *Listeria* shares antigens with other bacteria. This being the case, agglutination titers should be interpreted with caution and preferably compared with the complement fixation test.

Listeriosis in sheep and cattle usually is readily recognized, and the etiological agent is frequently recovered without difficulty. The main clinical manifestations caused by *Listeria* in ruminants, swine, and man are meningoencephalitis, septicemia, and abortion. In animal infections, there is a definite seasonal distribution. The greatest number of animal cases occur during the winter and spring months. This does not appear to be true of human infections. Sex and age distribution in both animals and man appear to show little differences in the incidence of infection, but the younger the creature, the more unfavorable the prognosis.

Therapeutic agents have been evaluated in animals and man, and the tetracycline group have been found to be the most effective; penicillin and sulfonamides in combination proved almost as effective. The in vitro sensitivity gives some indication of the agent of choice. Vaccination of animals has been attempted, but the trials have not been wholly successful. Further tests, however, should be made.

Since 1950 there have been 83 human cases in the United States verified by the Communicable Disease Center's laboratories, and since 1954 there have been 2,106 animal cases (representing herd and individual cases). We may conclude, therefore, that listeriosis is a public health problem, especially since we do not know the frequency of occurrence nor do we understand the epidemiology of the disease. We do know that it is widespread, that it occurs in humans and animals, and that it is frequently fatal. We also know that the premature infant and the aborted fetus may be due to congenitally acquired *Listeria* which does not manifest itself in an overt illness of the mother, that all ages and both sexes are susceptible, and that animal contact is not necessarily a factor in the epidemiology of listeriosis.

Animal Disease and Biological Warfare

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Biological warfare may be defined as the intentional use of living micro-organisms or their toxic products for the purpose of reducing the military effectiveness of man. This use includes damage to or destruction of his food sources.

Do we have reason to concern ourselves with defense against such warfare? History answers in the affirmative. From the earliest to most modern times it tells us that nations at war will and have used every known weapon system that offers them a possibility of achieving victory.

What is the relationship of animal disease to defense against biological warfare? A brief exploration of three major facets of a biological warfare defense program reveals a close and vital relationship.

First is the field of potential antihuman agents. Would not the zoonoses, animal diseases transmissible to man, such as mycotic

infections, tularemia, and the viral encephalitides, to name but a few, dominate any such list? They certainly possess some of the characteristics considered in a good biological warfare agent such as high infectivity and stability.

Second is the field of antianimal agents. The widespread outbreak of such foreign animal diseases as foot-and-mouth disease, African swine fever, rinderpest, and Newcastle disease in our domestic animals, to mention but a few, could result in a drastic, if not complete, reduction of available food supplies. This would be particularly true if coupled with a successful destruction of crops.

Third, and perhaps the only silver lining in the defense picture, is the far-reaching benefits human health has received as a result of research in animal disease. Advances in epidemiology, bacteriology, and immunology, for example, are already actively utilized in advancing the health of the Nation.

Orphan Viruses of Man and Animal

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Refinement of tissue culture methods and expansion of their use into the field of virology has brought into focus large numbers of viruses heretofore unrecognized. It is well known that families of viruses, such as herpes and pox, exist in different species, and now it appears that there are also enteric viruses for a number of different animal species. These are enteric cytopathogenic orphan viruses for humans (ECHO), monkeys (ECMO), bovines (ECBO), and swine (ECSO).

ECHO viruses, of which there are at least 19 antigenic types, have been isolated from normal children and from patients with aseptic meningitis syndrome. Because the human diseases to which they belonged were unknown, and because they failed to produce illness in laboratory animals, including infant mice, they were originally called "orphan viruses."

The difference in colony (plaque) morphology and in host cell susceptibility have suggested that the ECHO viruses may be divided into two groups. The selection of the proper serum for antigenic identification has been made easier by such a preliminary grouping.

ECMO viruses are included among the simian viruses of Hull and his colleagues. They may be divided into three groups according to their plaque morphology and patas cell susceptibility. Positive CF reactions were obtained between strains of one group of ECMO viruses and human serum known to contain adenovirus antibodies.

ECBO viruses isolated by Kumin and by Klein grow readily in bovine kidney cultures; some have been found to propagate in monkey kidney cells, but not in HeLa cultures. Those tested have proved to be antigenically distinct from human viruses.

ECSO viruses were isolated from newborn pigs by Moscovici in Italy. The virus grew rapidly in monkey and swine kidney cells, but HeLa cells failed to respond.

In view of this study it is believed that colony morphology and cell susceptibility, classical criteria for classification of enteric bacteria, are of similar value for identification of orphan viruses isolated from man and animal.

Viral Hepatitis in Animals and Man

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Viral hepatitis has been described in man and other animals, including dogs, pigs, mice, and ducks. Such viral agents appear to be characteristically narrow in their host susceptibility. Since for laboratory investigations the viral hepatitis agents of man are not transmissible to other animal species and are difficult to evaluate in tissue culture, mouse hepatitis virus has been studied as a possible prototype of the human equivalent.

Mouse hepatitis virus in embryonated chicken eggs induces changes resembling the effect of acute serum from viral hepatitis of man. Inoculums containing virus induce an

increase in the number of lymphoid cells in the allantoic fluid; in inoculums containing heat-inactivated virus, the cellular response is absent. Serial passage of inoculated egg material has failed to show reproduction of murine and human hepatitis viruses in avian tissue. Four logs of mouse-infective virus are required to elicit the cytological response in embryonated eggs, thus indicating that the egg is very much less sensitive to virus than the natural host.

Mouse hepatitis virus does not propagate in "L" strain of mouse fibroblast in tissue cultures, and human hepatitis virus has induced no detectable cytopathogenic effect in cultures of human tissues.

A soluble complement-fixing antigen has been extracted from liver emulsions of mice infected with hepatitis. The antigen can withstand desiccation, heat, extraction with ether, and freezing; it does not sediment at 120,000 gravities for 2 hours. "Normal" liver does not contain this antigen. An antigenic relationship of mouse hepatitis virus to human disease has not been demonstrated.

Neutralizers of Human Viruses in Animal Serums

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Certain domestic animals, particularly cows, have neutralizing substances in their serums against certain human viruses such as polioviruses, coxsackie, and adenoviruses. These antibodies occur in the absence of any known infection with the agents and raise the question of their interpretation. Are they true antibodies?

A study of the neutralizing substance against polioviruses in cow serums revealed the following characteristics: It is a globulin, heat stable at 60° C. for 30 minutes and highly specific. Some serums have no neutralizing substances; others have neutralizing substances to types 1, 2, and 3 polioviruses or combinations of these. There is evidence of passive transfer: newborn calves commonly have neutralizing substances that disappear at 4 to 5 months and gradually reappear over a period of time in the traditional fashion of antibodies. Titers are variable and may be quite high: dilutions greater than 1:128 neutralize 100 TCD.

A review of the literature indicates that although certain nonspecific inhibitors may have one or more of these properties, no substance other than specific antibody is known to have all of these properties.

Even when one has determined that he is dealing with a true antibody, a more difficult question remains. What is the nature of the antigenic stimulus for the antibody? Cross reactions between viruses of which there are already many examples (canine distemper and measles, vaccinia and variola, swine influenza and influenza, psittacosis and lymphogranuloma venereum) make final interpretation or origin impossible.

The problem is particularly difficult in surveys of animal serums when one does not have the orienting information of a known reservoir, or an epidemic situation with a characteristic clinical picture and paired serums to observe a fourfold rise in titer.

Although one may conclude that the neutralizing substances in bovine serums are true antibodies that react with polioviruses, coxsackie, and adenoviruses, the final interpretation as to the origin of these antibodies requires the isolation of a specific agent that can explain the antibody pattern. In the absence of such isolations, the origin must remain an object of closely reasoned but inconclusive speculation.

Brucellosis in Livestock

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Brucellosis in livestock continues to be an important economic burden and public health threat in many sections of the United States.

Since 1934 a cooperative State-Federal program for the control and eradication of bovine brucellosis has been in operation. During that time the number of reactors disclosed through blood agglutination testing has declined from

11.5 to 1.8 percent of the animals checked. A similar reduction has occurred in the number of herds carrying the infection. For fiscal year 1935, infected animals were found in 36.2 percent of the blood-tested herds. As of June 30, 1957, this figure was 10.5 percent.

In October 1954 the bovine brucellosis eradication campaign was accelerated by additional Federal funds, and progress during the past 3 years exceeded that reported for any similar period since the program's inception. At present approximately half of all cattle in the United States are under supervision for the control and eradication of brucellosis.

The initial goal of the eradication campaign is to establish and maintain certified brucellosis-free areas. This designation signifies that the infection appears in no more than 1 percent of the animals and 5 percent of the herds. At the end of fiscal year 1957, 735 counties and 7 entire States were certified. Another 712 counties were actively working on programs leading to certification. This means that nearly 50 percent of all counties in the United States, Puerto Rico, and the Virgin Islands are either certified or are rapidly approaching that status. It is estimated that by June 30, 1958, a total of 16 States will be certified.

If the present level of field operations can be maintained, there is every reason to believe that the incidence of bovine brucellosis throughout the United States can be reduced to 1 percent or less by 1960.

Brucellosis in Man

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With more widespread pasteurization of milk and other dairy products, brucellosis in the United States has become almost entirely an occupational disease affecting persons intimately exposed to infected animals or their tissues. In the last 10 years the number of cases reported annually has dropped considerably; nevertheless, if one excepts salmonellosis deriving from animal sources, brucellosis in the United States still has a higher reported incidence than any other disease of animals transmitted to man.

While great strides have been made in the last few years in the control of bovine brucellosis, and the incidence of the infection in cattle has been greatly reduced, the decrease in notified incidence in man cannot be clearly related to the success of the control program. Swine continue to be an important source of infection for man.

Despite the decrease in the number of reported cases, the problem of establishing the diagnosis of the disease in man remains an important one. Isolation of the organism from the patient is the only proof of diagnosis. A significant titer in the standard seroagglutination test, or a rising titer, provides presumptive confirmation of a clinical diagnosis. In chronic brucellosis a fluctuating titer is suggestive of active disease. The widespread and often indiscriminate use of the broad-spectrum antibiotics makes cultural proof more difficult, and greater dependence must be placed upon the agglutination test. The skin test has no value as a diagnostic aid.

The current therapy of choice consists of a combination of dihydrostreptomycin and tetracycline, with or without the addition of sulfadiazine or triple sulfonamide. As all presently available drugs primarily suppress the infection, treatment must be continued for a period of time sufficient to allow the body to dispose of the infection. Bed rest is essential. Local lesions may require longer medical treatment or definitive surgical treatment.

Vector Relationships of Arthropod-borne Encephalitides in North America

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Although much remains to be learned about the ecology of the arthropod-borne encephalitides in North America, past and recent studies

have provided a considerable knowledge of these diseases. The most probable hosts and vectors have been revealed.

Field investigations have shown fresh water swamps to be the foci of eastern equine encephalitis (EEE) infection. Wild birds captured in swamps have frequently been found infected, and numerous virus isolations have been made from *Culiseta melanura*, a swamp-inhabiting mosquito which feeds principally upon birds.

Because of its restricted habitat and feeding preferences, *C. melanura* is probably unimportant in the direct epidemic spread of EEE to horses and man. Although it appears to play the important role of maintaining the virus in its endemic foci, the spread of the disease outside of these foci is most likely dependent upon other mosquito species which feed commonly upon horses and man.

Certain conditions appear necessary to permit an epizootic in horses (and an epidemic in man) to occur. Bird infection within the swamp foci would need to be at high level, furnishing a relatively great source of virus for mosquito infection. This condition would depend upon an adequate population of *C. melanura* (and perhaps other susceptible bird-feeding, swamp-inhabiting species), and a low immunity rate in the bird population. The latter would, in turn, depend upon a light infection rate the previous year. With a large number of birds infected, inevitably some of them fan out into adjacent nonswamp areas and serve as sources of infection for other mosquito species which will feed upon horses and man. The scattered distribution of the infected birds, together with a lack of strong bird-feeding proclivity on the part of the mosquitoes, results in only a very low mosquito infection rate; this must be compensated for by large mosquito numbers. If, in addition to all this, there is also a low immunity rate in the horse population, conditions are proper for an epizootic. Once the epizootic is under way, some transmission from horse to horse by mosquitoes and biting flies without the intervention of birds is probably also possible.

The ecology of western equine encephalitis (WEE) has undergone intensive investigation over many years. Serologic and virus isolation studies in wild birds have firmly established their role as the most important hosts, and hundreds of isolations of the virus from *Culex tarsalis* attest to the close association of this mosquito species with natural sources of infection. Since it is widespread in distribution, occurs in large numbers, feeds freely upon man and horses as well as birds, is exceptionally susceptible to infection, and transmits with high efficiency, it fulfills requirements for both an endemic and epidemic vector. It undoubtedly is responsible for the bulk of the WEE transmission to birds, horses, and man throughout its range in the western part of the United States. *Aedes* mosquitoes appear to play only a minor role in epidemic transmission.

Until a few years ago the distribution of WEE was believed to be limited to that of *C. tarsalis*. It is now known that it does occur in mosquitoes and birds in the East in the absence of *C. tarsalis*, however, but does not cause disease in man and is only rarely seen clinically in horses. In the East the enzootic status of WEE appears to be similar to that of EEE, with *C. melanura* in fresh-water swamps playing the role of the principal enzootic vector. The absence of a highly efficient epidemic vector, such as *C. tarsalis*, is probably the main factor in keeping the virus within discrete enzootic foci. Also, laboratory studies have shown that animals immune to EEE respond to WEE infections with significantly lower viremias. This may be a contributing determent to the epidemic spread of WEE in areas where a high proportion of birds and horses possess EEE antibody.

St. Louis encephalitis (SLE), like EEE and WEE, is primarily an infection of birds transmitted by mosquitoes, with man an unfortunate, accidental host. The virus of SLE differs from those of EEE and WEE, however, in having a reversed mosquito susceptibility range. It readily infects all species of *Culex* mosquitoes which have been tested, whereas EEE and WEE viruses find most *Culex* species (except *C. tarsalis*) almost totally refractory.

In the far west, *C. tarsalis* is the main vector of SLE and, as would be expected from the breeding habits of this mosquito, most of the human cases are rural. A different situation

exists in the central and east central States, where *C. tarsalis* is not abundant. There *Culex pipiens* or *Culex quinquefasciatus* are apparently the important epidemic vectors and a high proportion of the cases are urban or suburban.

The mechanics of an urban epidemic appear clear. Infected wild birds probably introduce the virus to high populations of suburban and urban *C. pipiens* or *C. quinquefasciatus*, which rapidly spread it to city-dwelling birds and chickens. These, in turn, serve as a ready source of infection for additional numbers of the mosquitoes. A consequence of the resultant bird epizootic is exposure of a large segment of the human population to infection by mosquito bite. The vectors responsible for the initial infection of the wild birds are unknown, but widespread sylvan mosquitoes may be involved.

Control measures through vector abatement are often economically impractical. Only urban SLE gives immediate promise of relatively inexpensive control. It is obvious, therefore, that continued investigations on the ecology of encephalitis are necessary.

Changing Picture of Murine Typhus

HARRY D. PRATT, *Communicable Disease Center, Public Health Service, Atlanta, Ga.*

The changing picture of murine typhus in the United States can be shown by comparing two 4-year periods, 1941–44 and 1953–56. In the first period the number of cases of murine typhus increased to a peak of 5,401 in 1944, while in the latter period the number of cases decreased to 98 in 1956. This is the first year since 1924 that less than 100 cases of murine typhus have been officially reported to the Public Health Service.

Treatment in the first period was largely symptomatic; today, broad spectrum antibiotics, such as chloromycetin, aureomycin, and terramycin, give quick and effective cures. The use of these new drugs, however, probably obscures the true incidence of the disease. They mask all types of rickettsia infection, making diagnosis with laboratory confirmation difficult or rare.

Prevention of murine typhus during the first 4-year period was based on controlling rat fleas, rat trapping, rat poisoning (using relatively ineffective rodenticides such as red squill), rat proofing, and sanitation. Today, in addition to these methods, there are powerful insecticides which control infected rat fleas for weeks or months. Many new rodenticides have been developed, particularly the anticoagulants, which control rodents effectively and thus limit the flea population.

Improved sanitation programs in cities throughout the United States, and increasing reliance of private industry on commercial pest control services, have probably had a long-term influence on the steady decrease of murine typhus.

John W. Cronin, 1905–1958

Dr. John W. Cronin, Assistant Surgeon General of the Public Health Service, and chief of its Bureau of Medical Services since November 1956, died of a heart attack March 26, 1958.

Born June 15, 1905, in Springfield, Ohio, he began his career with the Public Health Service in 1932. As chief of the Hill-Burton program from 1949 to 1956, he is credited with rallying State support for the construction and enlargement of hospitals, nursing homes, and clinics throughout the United States.

Dr. Cronin was a graduate of Miami University, Oxford, Ohio, and of the Cincinnati University College of Medicine.

publications

Home Accident Prevention Text

PHS Publication No. 564. 1957. 24 pages. 15 cents.

The Home Accident Prevention Text provides both guidance and reference suggestions for all categories of local public health workers whose cooperation will be required in a local home accident prevention program. Following an introductory survey of environmental, physical, mental, and emotional factors in home accidents, the booklet analyzes the roles of the health officer, public health nurse, sanitarian, and other health personnel. The important contribution of the private physician to the success of local programs and the value of cooperation with other agencies in the community are stressed.

One Way to Develop Local Home Accident Activities

PHS Publication No. 566. 1957. 10 pages. 35 cents.

Designed to aid local health departments, One Way to Develop Local Home Accident Activities outlines a "learning by doing method." It presents a four-point program: staff orientation, local resources, the local problem, and suggested activities.

Sources of Morbidity Data, Listing Number 5, 1957

PHS Publication No. 565. 1957. 81 pages.

This fifth listing of projects in the files of the Clearinghouse on Current Morbidity Statistics Projects describes 105 projects not previously reported. The projects are grouped according to the major type or types of disease, injury, or impairment with which they deal.

There are three indexes: the projects by type of data collection, the organizations and institutions responsible for the research, and the principal investigators. Also included is a section of supplementary notes on projects in progress when their descriptions were received by the clearinghouse for inclusion in previous listings.

Since the listings of the clearinghouse are published primarily for the use of actual and potential contributors, the number of bound copies for other distribution is limited. Tear sheets of the description of each study are available, however, to research workers or persons planning public health programs.

Survey of Compounds Which Have Been Tested for Carcinogenic Activity, Supplement 1

PHS Publication No. 149. Supplement 1. 1957. By Philippe Shubik and Jonathan L. Hartwell. 388 pages. $3.50.

This supplement surveys the literature from 1938 through 1943 on compounds that have been tested for cancer-producing properties in experimental animals. Having the same format as its predecessor, it combines in tabular form experimental data on nearly 1,000 compounds, of which about one-fifth are cancer-producing in animals.

The compounds are arranged alphabetically in classes, and the data cited include reference, species and number of animals, route of administration, number and type of tumors, and duration of experiment. A cumulative compound index, one of several indexes, includes the listings in both PHS Publication No. 149 and the supplement.

Because of the growing importance of chemicals in food, drugs, and cosmetics, and the increasing awareness of the possible long-range effects of these and other materials such as the products of combustion of tobacco and gasoline on the human organism, the book should be useful to anyone interested in environmental cancer as well as cancer investigators.

Research Grants and Awards, National Institutes of Health, 1957

PHS Publication No. 571. 1957. 147 pages. 45 cents.

Health research facilities grants, research fellowships, and research grants awarded by the National Institutes of Health during fiscal year 1957 are listed separately by State and institution.

Toward a Healthier World—Your Career in Sanitary Engineering

PHS Publication No. 579. 1958. 16 pages; illustrated. 25 cents.

This is the first career guidance pamphlet to describe sanitary engineering. Designed especially for high school students, it covers past achievements of sanitary engineers, their present and future work, the need for such engineers, salary, possible employers, and educational requirements.

This section carries announcements of new publications prepared by the Public Health Service and of selected publications prepared by other Federal agencies.

Unless otherwise indicated, publications for which prices are quoted are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Orders should be accompanied by cash, check, or money order and should fully identify the publication. Public Health Service publications which do not carry price quotations, as well as single sample copies of those for which prices are shown, can be obtained without charge from the Public Inquiries Branch, Office of Information, Public Health Service, Washington 25, D. C.

The Public Health Service does not supply publications other than its own.

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