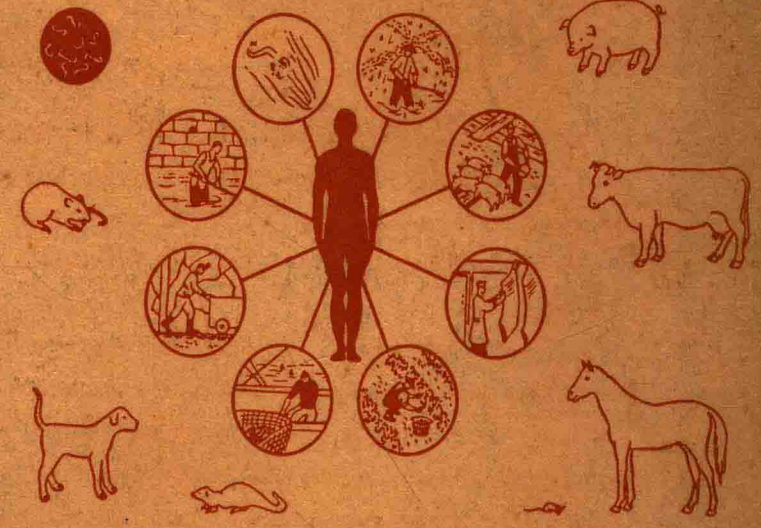
THE ZOONOSES

in their Relation to



RURAL HEALTH

KARL F. MEYER

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BY
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INTRODUCTION

MAN REALIZED centuries ago that epizootics continuously threaten to exterminate those animals, both wild and domestic, on which he is dependent. Later he learned that these epizootics at times endanger his own life. Today it is fully appreciated that animals expose rural people to certain infections that drain their vitality and make their labors less profitable, but discussions of rural health practice rarely consider this. It is timely, therefore, to analyze the available knowledge of the most important of these infections and the methods of control that public health and zootechnical authorities may adopt to improve rural health, welfare, and economy.

The word "zoonosis," originally chosen by Virchow, is applied to infections of animals that are secondarily contagious to man. Certain epizootic or enzootic infections of domesticated animals are particularly hazardous to country dwellers. The care, the breeding, frequently the butchering or the consumption of flesh of diseased or invisibly infected animals offer unlimited opportunities for exchange of the infective agents. Bacteria, fungi, protozoa, viruses, and helminths may invade the human body by any of several routes—through the mouth, the skin, the mucous membranes, or the respiratory tract. Direct contact with infected animals or animal products and consumption of animal products contaminated during processing and delivery are the most common modes of transmission of the zoonoses.

Bacterial, viral, and protozoan parasites conveyed by contact with wild animals or by vectors in forests and fields adjacent to human dwellings are equally hazardous. The farmer may acquire the infection without ever having had direct contact with the infected animal host. The reservoirs of infection in the lower animals now dominate the problems of zoonoses in their relation to human welfare.

Infective agents may be totally inconspicuous in their natural animal host; in fact, the infections they cause are most frequently chronic, latent, and subclinical.

This paper was presented in the course of the Technical Discussions, Seventh General Assembly, World Health Organization, May 14, 1954.

Without a comprehensive understanding of the ecology of the mammals, birds, and arthropods—infected and infectable—it is impossible to be fully aware of the complexity of these infection chains. It is important to understand that biologic and ecologic factors, known and unknown, are constantly affecting both host and parasite. A high incidence of infected arthropod vectors (for example, plague-infected fleas or encephalitis-virus-carrying mosquitoes) does not necessarily initiate epidemics among the people of regions heavily seeded with reservoirs of infection. Without comprehensive knowledge and understanding of the infective agent, its vector if any, and its reservoirs (usual and accidental) and their interrelationship, it is impossible to gauge the potentiality of the reservoirs and to decide on the proper scale of preventive and suppressive measures to be taken. Today the real problem of suppressing or eradicating zoonoses is much less a problem of wiping out overt disease than of learning the usual habitats of infective agents and then of dealing with what are often ineradicable mammalian, bird, or arthropod reservoirs.

The ebb and flow of human illness attributed to zoonoses reflects the activities of the infective agent in the extrahuman reservoir. This is particularly obvious in arthropod-borne infections and some others that cause trouble sporadically. At least 86 infections of domestic and wild vertebrates are a present or potential threat to man's health.

A large body of knowledge and experience—and in certain parts of the world the desire and means to apply it—is now available, but for the most part the people directly concerned with animal husbandry are not familiar with it. They can be made aware of the relationship between maintenance of animal health and the prevention of zoonoses only through proper education. Too often the prolonged physical suffering and reduced capacity for work caused by some zoonoses are accepted by rural people throughout the world as inevitable. Only to a limited degree do they appreciate that the zoonoses are detrimental to their health, that the ravages of these infections impose tremendous economic losses, direct and indirect, thus affecting their welfare, and that through their own efforts they may help to remedy this unfortunate situation.

One need only to consider all of the adverse effects of the zoonoses to realize the urgency of control: loss of life and acute and chronic illness of inhabitants of rural areas; loss of life and impairment of productivity of farm animals; and loss of life and acute and chronic illness of city dwellers to whom the zoonoses may spread. Control, then, has its humanitarian aspects, in that through it lives can be saved and illness

prevented; it also has far-reaching economic aspects—these infections may mean mere loss of profit, or they may mean critical want. In some areas they preclude the raising of livestock altogether (as in certain parts of South Africa where trypanosomiasis makes cattle and sheep raising impossible in fertile pasturelands), in others they make an already poverty-stricken group poorer still and deny food supply to undernourished populations. Their destruction of food alone is a major economic problem. Some of the zoonoses are most dangerous because of their direct effects on the health of rural populations, making habitation in rural areas impossible or hazardous; some are more important because of their effect on the world's food supply.

The available statistics on these infections have until recently, with few exceptions, failed to impress public health workers with the extent of the threats to people leading a rural life. Awareness of the full implications of the zoonoses has prompted some public agencies to develop programs that will ultimately reduce their incidence and in a few countries will completely eradicate some of them. Enlightened livestock owners, eager to eliminate dangerous animal diseases, can contribute greatly to the achievement of some of the goals set by public health workers, but there is little assurance that even part of the program can be realized until the concept of prevention permeates more effectively the services now attempting to control zoonoses.

Prevalence of the Zoonoses and the Inadequacy of Notification

Inadequate reporting contributes greatly to the difficulty of knowing which of the zoonoses should be given primary consideration and in visualizing the magnitude of the problems of prevention. The inadequacy results from two deficiencies: diagnostic facilities either do not exist at all or are not accessible in many areas, and there is a lack of official measures either requiring notification or making voluntary notification possible.

The available information on the geographic distribution of some of the major zoonoses and their reservoir hosts are summarized in the tables on pages 6 and 30. Knowledge of their real prevalence is contingent on morbidity and mortality records of proven and suspected clinical human and animal infections collected by various groups, including government agencies, the International Office of Epizootics, the World Health Organization, and the Food and Agricultural Organization. With few exceptions, dependable morbidity data on the extent of the infection in the animal reservoir—the real hazard to human health—

have not been collected. Countries or regions are suspected or tentatively considered to be infected with certain zoonoses when human infection attributable to contact with an animal host has been proven. Notification of public health services of these human sentinel cases has been largely responsible for the interest now being developed by health agencies. For some countries this is perhaps the only means by which the existence of a zoonosis may be brought to light. In the future the inadequacy of this means must be recognized.

Human preventive medicine demands these basic steps: notification of the proper agency of the occurrence of an infectious disease, confirmation by laboratory tests if necessary or possible, and collection of statistics which will permit accurate enumeration of the kinds of infection, the places in which they were found, and the circumstances under which they were discovered. It was recognized long ago that human communicable disease must be reported promptly so that health departments can institute control measures at once. Not until 1920, however, after an outbreak of rinderpest in Europe, was it deemed necessary to organize an agency—l'Office Internationale des Épizooties—whose principal object is collecting and bringing to the attention of government veterinary services facts concerning infection of animals, not necessarily zoonoses. As a sequel to this international development, many governments have passed new acts regarding notification and have assigned new powers to the appropriate agencies in the event of epizootics.

Such official measures are certainly basic steps, but reporting still depends largely on the initiative of the owner of the animal or on the representative of a veterinary or zootechnical agency entrusted with the supervision of livestock who desires that the disease be effectively controlled. Until trained personnel—veterinarians and auxiliary workers—are assigned the task of taking accurate animal censuses, it is obviously impossible to collect proper statistics on animal diseases, particularly zoonoses. In some countries reporting facilities are totally undeveloped. Data on reportable or notifiable animal diseases are obtainable in certain states and countries, but in many only a few diseases fall into this category. Data on nonreportable diseases are usually inadequate or nonexistent, depending on the initiative of individual veterinarians. Sample surveys to explore the problem of obtaining information from livestock owners or farmers about morbidity and mortality among their animals have been concerned more with death and disposal than with morbidity. Yet, morbidity of domesticated animals

may cause greater economic losses than their death, and create continuing sources of infection for the country dweller.

In order to devise a scheme for prevention and control of the zoonoses and their elimination as public health problems, an adequate system of reporting animal diseases must be inaugurated; animal morbidity and mortality statistics must be collected before the prevalence of the zoonoses can be properly appraised and documented. Reliable information on a sufficiently large cross section of the animal population would be of the greatest service for the following reasons: (1) It would reveal the incidence and epidemiologic importance of the zoonoses. (2) It would point out the direction for new investigations and for extension of the old. (3) It would suggest where control could be instituted most profitably. (4) It would measure the over-all effectiveness of control. (5) It would reflect the influence of protective action on the incidence or severity of a particular zoonosis in man.

In the United States the veterinary public health services in some states have experimented with a simple machinery of reporting animal diseases. These services, in coöperation with state health departments, have invited veterinarians to participate in an epizootologic intelligence program. The veterinarians receive an instruction sheet and a supply of report cards similar to those on which a physician reports human communicable diseases. If the veterinarian assists in the reporting of the zoonosis, he is appointed a collaborating epidemiologist in the state department of health and in the United States Public Health Service. In some other countries the livestock owner or herdsman is trained to record and report disease and death in his flock. A work card or report form is provided the owner, who records any event relevant to the health of his animals on the day on which it occurs. A veterinarian looks at the form from time to time, adds professional comment to the record, and provides the owner with a diagnosis if possible. Ultimately the data are sent to the national center; there they are analyzed and the resulting information is widely distributed. By such means the rural health agency, particularly the veterinary profession, will in time be supplied with the necessary morbidity and mortality statistics concerning the zoonoses (U. S. Livestock Sanitary Association, 1948–1952; Egan, 1950).

The presentation that follows concerns selected aspects of some infections of animals that are found in the immediate environment of a large part of the world's rural population. A few problems of more localized interest will be considered briefly.

TABLE 1

MAJOR ZOONOSES RECOMMENDED TO BE MADE NOTIFIABLE THROUGHOUT THE WORLD

(Recommendations by the World Health Organization)

Common name of the infectious disease	Principal reservoirs	Prevalence
Anthrax	Mammals	Eastern Mediterranean, west and southeast Asia, Latin America
Brucellosis	Goats, sheep, cattle, swine	Mediterranean area between 45° north and south (melitensis). Cattle: cosmopolitan. Swine: U.S.A.
Encephalitis, arthropod-borne (identified by type)	Birds, sheep, rodents	U.S.A., Latin America, Africa, central Europe, U.S.S.R., Far East, Australia
Hydatidosis	Dogs, ruminants, swine, wild carnivores	Eastern Mediterranean area, southern South America, South and East Africa, New Zealand, southern Australia, Siberia
Leptospirosis (identified by type)	Rodents, cattle, swine, wild carnivores, horses	Cosmopolitan
Plague	Wild or commensal rodents	Asia, Malta, Azores, Africa, Madagascar, North and South America, New Caledonia
Q fever	Cattle, goats, sheep	Cosmopolitan
Rabies	Dogs, cats, wild carnivores, bats	Cosmopolitan
Salmonellosis (identified by type)	Birds, mammals	Cosmopolitan
Trichinosis	Swine, wild carnivores, Arctic animals	North America, central Europe, Spain, Argentina, Brazil, Chile
Tuberculosis, bovine	Cattle, dogs, goats	Cosmopolitan (around urban centers)
Tularemia	Rodents, carnivores, birds	U.S.A., Japan, Europe, Asia

Major Zoonoses

Anthrax.—Primarily an acute disease of herbivorous animals—cattle, sheep, and goats—anthrax is common in nature; the level of organization of the livestock industry determines its prevalence among domesticated animals in any given region. In most of the heavily infected areas livestock is raised or tended in small herds by farmers or nomads whose methods have remained unchanged for centuries. Animals sick of anthrax are left to die in the fields, and this perpetuates and spreads the infective agent. Not infrequently the hides, hair, and wool are salvaged, sold, and reach the world market. Contaminated meat and meat products are used as food, and rural human infections are probably by no means uncommon. Agricultural human anthrax is often also acquired during handling, skinning, or butchering of infected animals. The constant flow of contaminated animal by-products such as hair, wool, and goat skin to industrial plants through international trade creates the problem of industrial anthrax in many countries that must depend on these importations (Wolff and Heimann, 1951). Although it is well known that raw bone meal from Asia and southern Europe may carry anthrax spores, some importing countries have made no provision for sterilization of this product. As a consequence, heavy livestock losses occurred in the United States recently (Steele, 1952).

In countries in which the livestock industry is well organized, anthrax outbreaks are generally prevented by vaccination of animals. When they occur they are well controlled and the animal by-products of anthrax-infected animals are rarely sold. Where the soil is heavily infected with spores and the livestock raisers cannot afford preventive measures, government agencies must provide low-cost or free vaccination of livestock with vaccines of proved potency in order to protect the health of the agricultural worker. Death from cutaneous human anthrax can be prevented if the diagnosis is made early and treatment with antibiotics is instituted promptly.

The Expert Group on Zoonoses of the World Health Organization and the Food and Agricultural Organization (1951) has set forth the available knowledge precisely, has pointed out clearly the interlocking responsibilities of health and agricultural authorities, and has recommended in detail protective measures against anthrax in industrial plants where potentially dangerous animal products are handled. This group emphasizes that farmers must be taught the early signs of this disease, that low-cost or free vaccination is needed, and that anthrax-

EPIDEMIOLOGY OF BRUCELLOSIS

BACTERIOLOGY

CULTURES (SPECIAL MEDIA: LIVER AGAR, ALBIMI, TRYPTOSE ETC.) AND ANIMAL INOCULATIONS

BLOOD, BILE-DRAINAGES, URINE, STOOLS, SPUTUM

BIOPSY OR AUTOPSY SPECIMENS LYMPH NODES, SPLEEN, LIVER BONE MARROW, FETUS AND PLACENTA

BRUCELLA SPECIES CHARACTERISTICS

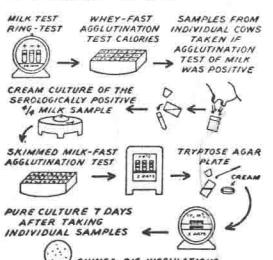
BRUCELLA SPECIES	CO_2	H_2S	AGG.-ABSORPTION
ABORTUS	+	+	ABORTUS
SUIS	±	+	ABORTUS
MELITENSIS	0	0	MELITENSIS

DYE TOLERANCE			
BRUCELLA SPECIES	FUCHSIN 1:25,000	THIONIN 1:50,000	METHYL-VIOLET 1:50,000
ABORTUS	+	0	+
SUIS	0	+	0
MELITENSIS	+·±	+·±	+·±

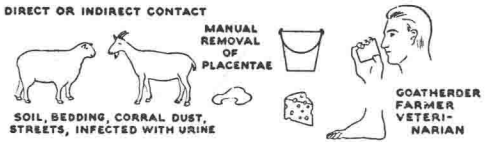
SEROLOGY (BLOOD SERUM OR MILK WHEY)

AGGLUTINATION TEST (TUBE METHOD OR RAPID PLATE TEST)

COMPLEMENT FIXATION



MELITENSIS



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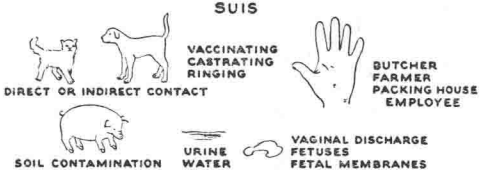
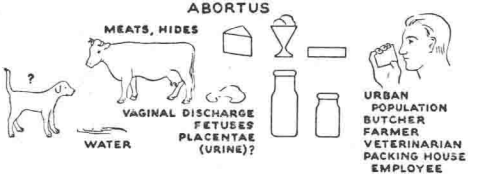


ABORTUS



PASTEURIZED OR BOILED MILK IS FREE FROM VIABLE BRUCELLA ORGANISMS

CLINICAL ASPECTS OF HUMAN BRUCELLOSIS

TWO GENERAL FORMS

1. AN ACUTE FEVER OF LIMITED DURATION FOLLOWED BY APPARENT RECOVERY
2. LONG-CONTINUED DISEASE WITH PERIODIC EXACERBATIONS

SYMPTOMS

ALL SYMPTOMS ENCOUNTERED DURING COURSE OF INFECTION CAN BE THOSE OF ANY OTHER DISEASE

FINAL DIAGNOSIS MUST BE BASED ON

SERO-AGGLUTINATION TEST SHOWING A CONCLUSIVE TITER

POSITIVE CULTURE (EVERY ATTEMPT MUST BE MADE TO GET A CULTURE FROM BLOOD, LYMPH-NODES OR BONE MARROW)

CONTROL

INDIVIDUAL PROPHYLAXIS- BUT ELIMINATION OF DISEASE IN ANIMALS IS MORE EFFECTIVE

SYSTEMATIC EXAMINATION OF HERDS

NOTIFICATION OF HUMAN AND ANIMAL CASES

MEAT AND MILK HYGIENE

EDUCATION OF STOCK OWNERS

Chart 1

contaminated animal by-products must be disposed of properly. The control methods it outlines fully may well serve as a guide to the development of international regulations for trade in wool, hides, and bone meal, so frequently the vehicles that introduce anthrax into countries importing these animal products.

Brucellosis.—This zoonosis causes more illness, misery, and economic loss than any other. Recent reviews (Kaplan, 1950; Inter-American Congress on Brucellosis, 1950; Hulse, 1952; WHO, 1954) leave no doubt that it is a world-wide problem, ranking high among the zoonoses in incidence. Despite an enormous amount of research and a plethora of publications, the nature of the problems it raises and its actual prevalence in large areas of the world are still not known. The epidemiology is summarized in chart 1. The officially reported cases of brucellosis in human beings fail to reflect the number of cases that occur; a conservative estimate places the actual number of infections at between two and three times the number reported.

Economic losses attributable to brucellosis are of appalling size. For Switzerland, Landis (1945) calculated the damage caused by abortion in domestic animals at 250 to 275 francs for each case; Hoffman and Flückiger (1945) concluded that the loss of reproductive increase exceeds 20,000,000 francs per year. The special commission set up in the United States in 1947 to investigate brucellosis estimated the yearly losses in production at $100,000,000, even though the infection rate in livestock there is estimated to be only 5 per cent. The losses consist of (1) decrease in milk supply, about $50,000,000; (2) loss in calves because of abortion, destruction of fertility and diseases during growth, about $5,000,000; (3) decrease in value of infected cows, about $32,000,000; (4) losses in other species of domesticated animals, about $13,000,000 (Meyer, 1953).

Aside from the economic losses the lowered capacity for work caused by chronic illness is a serious problem in many countries. Such losses are heaviest in Latin American and Mediterranean areas with their high prevalence of *Brucella melitensis* infections.

The World Health Organization and the Food and Agricultural Organization, advised by an expert panel comprising medical and veterinary experts from all parts of the world, closely collaborating with the International Office of Epizootics and several inter-American congresses, are attacking the problems of brucellosis on a world basis. A new outlook—complete eradication of bovine brucellosis, rather than adaptation to it—guides the measures taken by these groups. The inci-

dence of caprine and ovine brucellosis, of tremendous social importance in the rural life of some countries, will also decrease under such a program.

There are still some obstacles: (1) The use of diagnostic tests as a guide to elimination of infected animals is frequently impossible or can be executed only with great difficulties. The tests themselves have some limitations; evidence now available indicates that the sero-agglutination test must be interpreted on a herd basis, not on an individual-animal basis. (2) The environs of human habitations where infected goats and sheep have been raised for decades are thoroughly impregnated with the infective agent. Even the most elementary sanitary measures cannot be taken in such areas until an educational program has paved the way. (3) If animals are to be tested and the infected slaughtered, a primitive population dependent solely on the goat for milk and milk products would have to have its stock replaced by government-subsidized importation of clean animals. Such a measure is not compatible with the economy of the countries most heavily burdened by this disease. (4) A suitable vaccine for use in sheep and goats has not been developed, although several laboratories have made preparations which show promise of protective ability, and large-scale field trials are contemplated. A great deal of basic scientific work is required before a method of vaccination can be recommended. This work unquestionably must include adequate study of the infection in the goat and sheep and its transmission to man. In an analysis of the principal measures of prevention and control, which depend essentially on immunization of calves in contact with infected animals and on adequate processing of milk and milk products, the Expert Committee on Brucellosis realized that knowledge and information about the protective procedure appropriate for many areas were inadequate. Wisely, the WHO and FAO have established 13 brucellosis centers throughout the world. Among other activities, they serve as study centers for the appraisal of diagnostic procedures, and they manufacture vaccines. Most important, they train clinical and laboratory workers and through fellowships are enabled to send staff members to institutes and conferences for further training. Through constant exchange of information the health and agricultural agencies entrusted with the prevention and ultimate control of brucellosis are advised concerning the pressing needs and problems to be met before the apparently simple principles can be applied.

The magnitude of the problem can be evaluated only through accurate reporting and statistics relative to the incidence of the disease in man

and animals. The importance of the different animal reservoirs should be weighed. The standardization of serologic, intradermal, and milk tests, the simplification of culture and typing methods, the standardization, improvement, or development of vaccines, particularly for use in small ruminants, and the testing of newer drugs for the treatment of human brucellosis are all parts of the concerted attack on the problem on a world-wide basis. It may serve as a model of planning, and results with far-reaching consequence may be confidently anticipated (WHO, Joint FAO/WHO Expert Committee on Brucellosis, 1951, 1953; WHO, 1954).

Arthropod-borne encephalitis.—Some aspects of the relationships of the arthropod-borne encephalitis viruses to their hosts and reservoirs in certain sections of the United States are known, but these interrelationships are only partly or not at all known in most infected areas—Latin America, central Europe, Russia, the Far East, and Australia. In some countries sporadic human infections are diagnosed every year. From time to time encephalitis appears in widespread outbreaks involving hundreds or even thousands of victims, as it did in Japan in 1924 and 1948, in St. Louis, Missouri, in 1933, in Minnesota, the Dakotas, and Canada in 1942, and in California in 1952. The annual known incidence of approximately 4,000 infections in horses, with an average mortality of from 60 to 98 per cent, places a high economic rating on this disease in the rural areas of the United States (Reeves, 1951).

One thing is clear from all epidemiologic investigations of this infection (chart 2): the virus is carried by many genera and species of mosquito and it may reside temporarily in birds, horses, and possibly other domesticated animals and rodents. In some areas the principal chain of infection in nature during the summer consists of transmission of the virus from bird to bird by infected mosquitoes. The abode of the virus during the interepidemic season remains a mystery. There is weighty evidence that St. Louis, Western, and Eastern encephalitis are maintained principally by the bird-mosquito-bird chain. The horse joins man in the role of accidental host; it is not the usual reservoir, as was originally suspected. Whether the same cycle characterizes the virus of Japanese B and Venezuelan equine encephalitis is not known. The multitude of vertebrate and invertebrate hosts, wild and domestic, none of which necessarily have symptomatic infection, and the observation that the Venezuelan virus may possibly be transmitted to man without vectors reflect the versatility and complexity of the epidemiologic behavior of this virus.

EPIDEMIOLOGY OF ARTHROPOD-BORNE VIRUS ENCEPHALITIDES

PRINCIPAL REPRESENTATIVES AND PROBABLE OR POSSIBLE PRINCIPAL VECTORS TO MAN

AMERICAS

- WESTERN EQUINE (W.E.E.)
  - CULEX TARSALIS AND OTHER MOSQUITOES?
- EASTERN EQUINE (E.E.E.)
  - MANSONIA PERTURBANS AND AEDES AND CULISETA SP.?
- VENEZUELAN EQUINE (V.E.E.)
  - MANSONIA TITTILANS
- ST. LOUIS (S.L.E.)
  - CULEX TARSALIS AND OTHER CULEX SP.?

ASIATIC

- JAPANESE B (J.B.E.)
  - CULEX TRITAENIORHYNCHUS AND OTHER CULEX SP.?

EUROPEAN – U.S.S.R.

- LOUPING ILL OR RUSSIAN FAR EAST (L.I. & R.F.E.)
  - IXODES RICINUS
  - IXODES PERSULCATUS

ARTHROPOD-BORNE VIRUSES OF UNKNOWN PATHOGENICITY TO MAN (POSSIBLY IN THIS GROUP)

AMERICAS

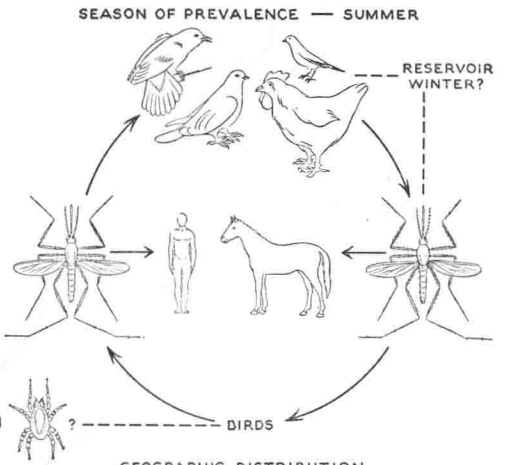
- CALIFORNIA
- ILHÉUS
- ANOPHELES A
- ANOPHELES B
- WYEOMYIA

AFRICAN

- WEST NILE (W.N.)
- SEMLIKI FOREST
- BUNYAMWERA
- NTAYA
- UGANDA S
- ZIKA
- MENGO

AUSTRALIAN

- MURRAY VALLEY (M.V.E.)



GEOGRAPHIC DISTRIBUTION

COMMON CLINICAL SIGNS

- FEVER
- MENINGEAL
  - HEADACHE
  - NAUSEA AND VOMITING
  - NUCHAL RIGIDITY
- SENSORIAL
  - DROWSINESS AND LETHARGY
  - STUPOR
  - COMA
  - MENTAL CONFUSION
  - DELIRIUM
  - MALAISE
- MOTOR AND COORDINATION
  - CONVULSIONS
  - TREMORS AND TWITCHINGS
  - MUSCLE WEAKNESS
- OCULAR
  - PHOTOPHOBIA
  - ABNORMAL VISION

VIRUS DIAGNOSTIC PROCEDURE

1. SEROLOGIC TESTS
   - COMPLEMENT FIXING ANTIBODY TITRE RISES DURING ILLNESS
   - NEUTRALIZING ANTIBODY PRESENT, GENERALLY PEAK LEVEL WITHIN FEW DAYS AFTER ONSET
   - CAUTION IN INTERPRETATION OF POSITIVE FINDINGS WITH THE ST. LOUIS, JAPANESE B GROUP CROSS REACTIONS
   - HEMAGGLUTINATION INHIBITION EXPERIMENTAL
2. ISOLATION OF VIRUSES
   - CENTRAL NERVOUS SYSTEM TISSUE, RARELY SPINAL FLUID OR BLOOD, BY INOCULATION MICE, EMBRYONATED EGGS OR OTHER SUSCEPTIBLE ANIMALS

CLINICAL LABORATORY PROCEDURE

- NO SPECIFIC TESTS ON BLOOD, SPINAL FLUID OR OTHER SPECIMENS WILL SPECIFICALLY DIFFERENTIATE FROM A WIDE RANGE OF OTHER CENTRAL NERVOUS SYSTEM INFECTIONS

CONTROL (PREVENTION)

- ARTHROPOD VECTOR
- VACCINATION, EXPERIMENTAL

Chart 2

Horses have been given inactivated Western encephalitis virus vaccine in some endemic areas; this has protected them against infection by the same virus, but not against Japanese B encephalitis. Selective species control of the vector mosquito, an expensive procedure, is thought to have been effective in limited areas as long as the mosquito population was of moderate density and had not acquired resistance to chlorinated hydrocarbon, but the menace to human health remains largely unchanged. To the people of rural areas visited by the encephalitides it would be a great comfort to know that effective control procedures are known and available. Present knowledge can give them no assurance.

Louping ill, known to exist in Scotland, England, Russia, Czechoslovakia, and Yugoslavia, infects sheep and man. Clinically apparent or inapparent infections in man due to contact with infected material or to bites of infected ticks have been reported. Aside from tick control, prophylactic vaccination is considered the most important preventive measure.

Hydatidosis.—Hydatid disease, infection with the larval state of the small tapeworm *Echinococcus granulosis,* is an infection man shares with sheep, dogs, cattle, and pigs, and is extensively distributed throughout the world (chart 3); the most important foci are given in table 1. The disease is prevalent wherever man, the dog and sheep, less commonly the cow and pig, are closely associated.

The factors in the infection of man are the infection rate with the tapeworm among dogs, and the number of infected dogs closely associated with man and contaminating his water and food or contaminating sheep and cattle pastures with eggs of the parasite. There is a rough parallel between the incidence of canine and human hydatidosis, but the infection rate in man is much lower. Sheep, cattle, and pigs become infected through defecation of dogs in pastures. The infection rate among sheep may vary from 7 to 70 per cent. The liver and lungs of such animals must not be used for food; these are condemned by meat inspectors. If dogs have opportunities to feed on the viscera of sheep, the spread of infection is greatly favored. The dog is not only the most important host, but he is the important link between man and any other reservoir of infection.

To prevent dogs from becoming infected they must be kept from any contact with raw viscera of any intermediate host, primarily of sheep. Thus slaughterhouse control is of paramount importance. Stray and superfluous dogs should be destroyed. All dogs should be kept out of places where they could infect food and pastures of sheep, cattle, and