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**JOINT WHO/FAO
EXPERT COMMITTEE ON
ZOOZOSES**

Second Report

WORLD HEALTH ORGANIZATION

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1959

JOINT WHO/FAO EXPERT COMMITTEE ON ZONOOSES

Stockholm, 11-16 August 1958

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JOINT WHO/FAO EXPERT COMMITTEE ON ZONOSSES

Second Report *

A Joint WHO/FAO Expert Committee on Zoonoses met at the Karolinska Institute in Stockholm, 11-16 August 1958, after the Seventh International Congress for Microbiology. Joint sessions on some aspects of subjects of common interest, notably influenza, were held with the WHO Expert Committee on Respiratory Virus Diseases which was meeting in the same building.

Dr K. F. Meyer was elected Chairman, Dr R. M. Mendy and Dr J. A. R. Miles Vice-Chairmen, and Dr A. W. Stableforth Rapporteur.

INTRODUCTION

In December 1950 a Joint WHO/FAO Expert Group on Zoonoses met to formulate recommendations on zoonoses for the guidance of WHO and FAO. Their report,¹ published in 1951, was considered by the present Committee in the light of advances made in the zoonoses dealt with in detail—namely, bovine tuberculosis, Q fever, anthrax, psittacosis and hydatidosis. Also, the Committee was concerned with several additional zoonoses of importance, including salmonellosis and leptospirosis, and other related problems of concern to the Member Governments of WHO and FAO. Three more major zoonoses, plague,² rabies,³ and brucellosis,⁴ have been dealt with by other expert committees of WHO and FAO, and are not considered in this report.

The Committee in dealing with the agenda had at its disposal working documents and publications (such as the report of the Study Group on

* The Executive Board, at its twenty-third session, adopted the following resolution :
The Executive Board

1. NOTES the second report of the Joint WHO/FAO Expert Committee on Zoonoses ;
2. THANKS the members of the Committee for their work ;
3. EXPRESSES appreciation to the Food and Agriculture Organization of the United Nations for its collaboration ; and
4. AUTHORIZES publication of the report.

(Resolution EB23.R31, *Off. Rec. Wld Hlth Org.*, 1959, 91, 18)

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1951, 40; *FAO Agricultural Studies*, No. 15

² *Wld Hlth Org. techn. Rep. Ser.*, 1953, 74

³ *Wld Hlth Org. techn. Rep. Ser.*, 1957, 121

⁴ *Wld Hlth Org. techn. Rep. Ser.*, 1958, 148

Leptospirosis¹) on several of the subjects under consideration, which had been prepared by members of the Expert Panel on Zoonoses and other authorities in the respective fields, and, of course, the 1951 report of the Joint WHO/FAO Expert Group on Zoonoses mentioned previously. The Committee decided to make the present report a self-contained document as far as possible, and borrowed freely from sections of the 1951 report dealing with bovine tuberculosis, anthrax, Q fever, psittacosis and hydatidosis, and of the Study Group on Leptospirosis. In every subject, however, major modifications were made by the present Committee in the light of scientific advances and field experience which have accumulated since these two earlier reports^{1,2} were published. The Committee expresses its great indebtedness to the work of these previous groups in facilitating the preparation of this report.

1. DEFINITION OF ZOO NOSES

In the 1951 report² the term zoonoses was defined as those diseases which are naturally transmitted between vertebrate animals and man. Views have been expressed in the literature proposing such terms as anthrozo-zoonoses (diseases transmitted from animals to man) and zoo-anthroponoses (diseases transmitted from man to animals). The Committee considers that the introduction of such terms into general use would have many drawbacks, including the fact that the definition as given above is now widely recognized and accepted as delineating a very important group of diseases common to man and animals. Recent findings, however, have shown that, apart from micro-organisms or parasites causing latent infection, there are other isolates, as yet not clearly defined in nature and of which many cannot so far be incriminated as producers of disease, which can be recovered from both man and animals. Some of these isolates have common characteristics and there is good reason to suspect that they can be transmitted between man and animals (see also pages 54-55).

The Committee, therefore, has slightly modified the definition of zoonoses given above, namely, "Those diseases and infections which are naturally transmitted between vertebrate animals and man".

2. PREVENTION, CONTROL AND ERADICATION

More than 100 zoonoses are now recognized (see Annex 1, page 56). Prevention, control and eradication of some of these diseases, particularly

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1956, 113

² *Wld Hlth Org. techn. Rep. Ser.*, 1951, 40

where domestic animals are the principal reservoirs, are responsibilities of considerable magnitude in every country. Domestic animal reservoirs of zoonoses are the sources of greatest danger for man, since he is in closest contact with such animals, and emphasis should therefore be given to these zoonoses in the development of animal disease control programmes. Notable successes have been achieved when such a procedure has been followed, for example, with bovine tuberculosis, brucellosis and rabies.

The discharge of governmental responsibilities for zoonoses control requires adequate financial support and close collaboration between the agencies of the government concerned, and particularly between the medical and veterinary services. The operation of inter-ministerial committees (health and agriculture) has proved to be an excellent means of achieving co-operative effort on the zoonoses, with appreciable concomitant savings due to pooling of funds, personnel and facilities. Such formal means of collaboration encourage free and frequent exchange of information on animal and human disease situations, the joint planning and financing of disease-control campaigns, improved food-hygiene services, and mutual assistance in laboratory and epidemiological work. Such committees should not, however, remain as paper organizations.

Attention to the zoonoses must be given at all levels of government—local, municipal, provincial and national. Local customs of the population in an area must be studied before control measures can be organized. Measures feasible in economically advanced countries may not be applicable to developing areas, so that adaptation and modification of these measures may be necessary. Administrative organization and activities with respect to the zoonoses in countries of different economic development were considered by an Advisory Group on Veterinary Public Health¹ convened by WHO, with FAO collaboration, in 1955. A chart concerning these activities is reproduced from their report in Annex 2 (see page 61).

The reporting of zoonoses is important in the development of any disease-control programme. Notification of disease outbreaks to the appropriate authority by the veterinarian, medical practitioner or other medical or veterinary personnel is the first step towards control. Administrative practice as to what diseases are to be reported and how they should be reported varies greatly from one region to another. This is justified in part by different conditions and different frequencies of disease. Annex 3 (see page 62) summarizes what can be done in this connexion.

Throughout the report there are a number of specific references to the importance of food hygiene measures in controlling and preventing the transmission of many of the zoonoses. Food is often a vehicle of infection, by consumption or through handling; the food may have come from

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1956, 111

infected animals or have been contaminated in processing.^{1, 2, 3} Due emphasis must be given to the importance of food hygiene as an integral part of zoonoses control, and of prevention of their transmission to man.

3. THE PAN AMERICAN ZOO NOSES CENTER

The Pan American Zoonoses Center was established in 1956 in Azul, Argentina, in response to the demands of the countries of the Americas. The Center is an international institution dedicated to promoting and strengthening activities against the zoonoses in those countries, its services being available to health departments, agricultural departments, educational institutions, and other agencies having an interest in zoonoses. It serves in the education and training of professional and lay technical personnel in techniques and methods to be used in combating these diseases. It stimulates zoonoses control and eradication campaigns in the different countries, and its staff is available for consultation on problems and activities related thereto. It conducts research with the aim of improving diagnosis and control of the zoonoses, and it promotes such research in governmental and private institutions in the Americas. It aids in the standardization of diagnostic methods and procedures for making and testing vaccines, sera, and other biological products used for the zoonotic diseases. It prepares and disseminates information about those diseases. All these services are aimed at helping the people of the Americas to reduce the social and economic burden caused by diseases transmitted between animals and man. The Committee considers the programme of the Pan American Zoonoses Center to be an important contribution to zoonosis work, and recommends that it be supported to the fullest possible extent.

4. SALMONELLOSIS

Salmonella infection is widespread in man and animals throughout the world. More than 500 different types of *Salmonella* have been described. Nearly all of them have been found in animals. The typhoid and paratyphoid bacilli are not discussed in this report.

Salmonellosis is most common in chickens, ducks and turkeys; it is frequent in rodents, less frequent in swine, not uncommon in cattle, sporadic in sheep, and occasional in various wild animals. Mortality is especially

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1955, 99

² *Wld Hlth Org. techn. Rep. Ser.*, 1957, 124

³ World Health Organization (1957) *Meat hygiene*, Geneva (*World Health Organization : Monograph Series*, No. 33)

high among new-born birds and animals. Direct and indirect losses are difficult to estimate accurately but are undoubtedly very high.

The reported incidence of salmonellosis in man and animals is increasing, partly because of greater interest in the problem. The real incidence, however, is also increasing. In this connexion, the growing national and international distribution of human and animal foods susceptible of contamination is of great importance. The closest co-operation of the medical and veterinary professions is required before the problem of salmonellosis on both the national and international scale can be solved.

4.1 Human salmonellosis

The incidence of human salmonellosis has not been accurately determined in any country, but in countries where observations have been made it is considerable. In England and Wales, for example, about 3000 incidents (comprising sporadic cases, family outbreaks or general outbreaks) are reported annually as compared with about 100 staphylococcus incidents. In the USA staphylococcus enterotoxin food poisoning is reported more frequently than salmonellosis, but the difference between the two countries is probably due to the more complete reporting of small outbreaks and sporadic cases of salmonellosis in England and Wales than in the USA. In the Federal Republic of Germany in recent years numerous outbreaks associated with sausage, boiled ham, pork, eggs and cheese have been reported. In Sweden some thousands of cases have occurred from the consumption of domestic and imported meat. In the Netherlands many outbreaks since the war have been traced to meat products. Human salmonellosis, therefore, is common in many countries, and in countries where observations have been made over a period of time it appears to be increasing. It causes preventable deaths in the very young and very old, and is responsible for much minor disability and discomfort in persons of all ages. Furthermore, it is an example of the distasteful transfer of bowel pathogens from man to man and from animals to man.

Salmonella typhimurium in most countries is the commonest salmonella isolated from cases in man and is a frequent pathogen in animals. Other types of salmonella wax and wane in incidence in man from time to time and from place to place. *S. heidelberg*, for example, was first isolated in England and Wales in 1951 but by 1957 had become the second most commonly isolated salmonella after *S. typhimurium*. No explanation of this increase has been found.

4.1.1 *Salmonellosis not apparently associated with food*

There are reports from many countries that human salmonellosis sometimes appears to spread through fomites or contact rather than

directly from contaminated food. Most of these reports describe outbreaks in hospitals, particularly children's hospitals or closed communities. In the general population, however, such a mode of spread is less easy to prove. Direct transmission has been observed among animal attendants, poultry processors, and others having close contact with infected animals.

4.1.2 *Foods associated with outbreaks*

A partial survey of recent literature shows that of 200 outbreaks associated with food, 5 were associated with fresh meat, 87 with processed or made-up meats, 41 with shell eggs (mainly duck eggs) and egg products (frozen eggs, egg albumen, egg yolks), 23 with cream confectionery, 10 with milk, and 34 with a wide variety of foods. Most of the incriminated processed and made-up meats were composed wholly or partly of pork products. Duck eggs, egg products in general, and pork products, therefore play a substantial part in the causation of salmonellosis in man.

4.1.3 *The human excretor*

The role of the human excretor as a source of salmonellosis is difficult to assess. Food handlers have been frequently blamed as the source of infection, because, on examination, they have been found to be excretors. In many instances, however, the food handlers were probably infected from the foods and were as much victims as the consumers of the food. In Britain and the USA, the carrier rate in the general population has been estimated at about 2 per 1000. Man is himself a reservoir of salmonellae and at any given time there must be many food handlers who are symptomless excretors.

A high standard of personal hygiene in food handlers, and the provision of adequate facilities for attaining this standard in commercial kitchens, packing plants and meat preparation factories, would certainly reduce the incidence of infection.

4.2 *Salmonellosis in animals*

4.2.1 *Salmonellosis in poultry*

A very large number of types of *Salmonella* have been isolated in one area or another from fowls (78 types to date), turkeys (62 types), ducks (31 types), geese, pheasants, partridges, pigeons and other birds. As a source of human infection poultry meat appears to be playing an increasingly important role.

Large-scale investigations in several countries have shown that the host-specific *S. pullorum* and *S. gallinarum* (responsible for pullorum disease of chicks and fowl typhoid respectively) account for some two-thirds of

the salmonella infections in poultry, and the former for over a half of the total, while the ubiquitous *S. typhimurium* accounts for a further 10%-20%.

S. pullorum and *gallinarum* can occasionally be isolated from turkeys, ducks and other birds, but most are from chicks or adult fowls. *S. typhimurium*, on the other hand, has been isolated from a large variety of birds, the highest incidence being in young or adult fowls, turkeys (forming in one area about half of the total infections), ducks, geese and pigeons. In some countries, as many as 10% of ducks may be faecal excretors.

The remaining types are mostly sporadic, being isolated from individual birds which usually show no signs of disease. Some types become widespread in a district or country for a few years, perhaps causing considerable disease, and then decline or disappear; examples are *S. thompson* in Great Britain, and *S. niloese* in Denmark. Certain serotypes are more common than others in some countries, for example, *S. oranienburg*, *anatum*, *bareilly* and *montevideo* in the USA, *S. enteritidis* in European countries. Variations are possibly due less to the susceptibility of individuals than to density of population, methods of husbandry, and the extent of critical examination made.

To summarize, the greatest loss to the poultry industry may be ascribed to three organisms, the relatively host-specific *S. pullorum* and *gallinarum* and the ubiquitous *S. typhimurium*. If infection with these can be brought under control, losses in poultry can be correspondingly reduced or eliminated. Poultry, however, act as a reservoir for a large number of salmonella serotypes, all potentially pathogenic to birds and man.

4.2.1.1 Control and prevention

The incidence of pullorum disease has been greatly reduced in the past 20 years in several countries by the method of blood testing and elimination of reactors. In one country the percentage of flocks containing one or more reactors was reduced by a voluntary scheme from 39% in 1939 to 9% in 1956. A corresponding reduction occurred in outbreaks of disease. Fowl typhoid (*S. gallinarum* infection) was at the same time brought under control by the same means. In other countries, similar or better results have been obtained, sometimes by compulsory methods.

Chemotherapy (for example, the use of nitrofurazone (5-nitro-2-furaldehyde semicarbazone)) in fowl typhoid outbreaks is sometimes effective in reducing losses, though at other times results are disappointing. Recent work has also shown that use of a living "rough" vaccine which does not interfere with the use of the agglutination test in diagnosis is a practical possibility. These methods are of undoubted value in commercial flocks and have a place in control measures in countries which cannot undertake an eradication programme.

The control of *S. typhimurium* infection is more difficult. The blood test for the detection of carriers is less reliable than in *S. pullorum* and *S. gallinarum* infections, largely because antibody levels fluctuate considerably, so that negative flock tests cannot be regarded as conclusive evidence of freedom from infection. The test has nevertheless been widely used in at least one country in turkeys, while in another country a stained-antigen plate test has been used, with useful results in flocks of turkeys, fowls and ducks. Despite their limitations, it is clear that blood tests can play a useful part in controlling and preventing outbreaks of *S. typhimurium* infection. As in infection caused by other salmonellae, blood testing should be supported by improvements in sanitation. Hens' eggs should be incubated separately from those of other poultry and of aquatic birds. Where practicable, hens should be run apart from other poultry; this applies particularly to breeding flocks.

4.2.2 *Salmonellosis in cattle*

Cattle may harbour many different types of *Salmonella*. *S. dublin* is specially adapted to cattle, and causes disease in calves as well as in adult animals in many parts of the world.

The clinical signs of infection in typical cases are those of a septic enteritis, with offensive-smelling diarrhoea, or dysentery, fever, anorexia and severe prostration. In milking cows a sudden drop in milk yields is observed, and in calves pneumonia, often fatal, may result.

The diagnosis is best made by the post-mortem bacteriological examination of spleen, liver, bile and mesenteric lymph nodes.

Animals that recover from the clinical disease will often excrete *S. dublin* in their faeces intermittently or regularly for long periods, even for life. The common site of the latent infection in the carrier animal is the gall bladder. The carrier state can also result from an inapparent or "silent" infection. Healthy carriers can transmit the infection to calves and adult cattle. The sale of carriers in markets plays an important part in spreading infection within an area and in introducing the infection and disease into clean areas. In herds where the disease has occurred it is therefore recommended that a bacteriological examination of faeces samples from all cattle be made in order to detect carriers. These, when found, should be segregated from the herd if it is not possible to remove them from the farm. In dairy herds with salmonellosis, in addition to these measures the milk must be adequately heat-treated, preferably on the premises, before distribution.

To a lesser extent than *S. dublin*, *S. typhimurium* may cause clinical disease in cattle. Carriers of *S. typhimurium* are encountered, though the carrier state probably does not last as long as in *S. dublin* infection.

Though other types of *Salmonella* do not play so important a role in clinical disease as *S. dublin* and *S. typhimurium*, inapparent infections

with them may be important from a public health point of view. They are sometimes found in meat and bone meal, fish meal and vegetable concentrates, and may thus infect cattle, the carcasses of which may in turn carry infection to human beings.

In all countries, it is recommended that bacteriological examination be made of organs from animals which have died from gastro-enteritis. For survey purposes, bacteriological examinations should be made of faeces samples from cattle gathered at markets or abattoirs, and of bile samples or mesenteric lymph glands from slaughtered animal carcasses brought together at knackeries, rendering plants, or other places dealing with casualties.¹

4.2.2.1 *Vaccines*

Vaccination has been practised in different countries in an attempt to prevent outbreaks of infection in calves. Though vaccines have been claimed to protect calves in some instances, they have apparently failed to do so in grossly infected areas or in premises harbouring a particularly virulent strain of the organism. The use of vaccines cannot, therefore, be generally recommended.

4.2.2.2 *Treatment*

Different chemotherapeutic agents and antibiotics have been tried. Though such treatment may diminish the losses in an acute outbreak, it will not prevent carriers developing. It cannot, therefore, be relied on for the elimination of infection from the herd.

4.2.3 *Salmonellosis in pigs*

The pig is the natural host of *S. choleraesuis* and may suffer from acute, subacute or chronic disease as a result of infection. When *S. choleraesuis* infection occurs in man it often results in serious or fatal disease. In addition to acting as host to *S. choleraesuis*, pigs rival fowls in the frequency with which they become infected with other types of *Salmonella*.

Though *S. choleraesuis* is characterized by its invasiveness in pigs, giving rise to bacteraemia which often proves fatal, it is usually confined to the mesenteric lymph nodes or intestinal contents. The sources of the localized infections in the intestinal tract are not known. Contaminated food-stuffs of animal or vegetable origin, or crowding of animals in sales, barns, trucks, or holding lots, may play a part.

There is evidence that *S. choleraesuis* is more likely to assume a pathogenic role in swine if the resistance of the animals is already lowered by

¹ For bacteriological methods see: World Health Organization (1957) *Meat hygiene*, Geneva (*World Health Organization: Monograph Series*, No. 33, Annexes 11, 12).

inter-current disease, for example swine fever (hog cholera), or poor environmental conditions. Outbreaks of salmonellosis can be initiated by apparently healthy carriers, these being present in many herds.

4.2.3.1 Control

Vaccination of pigs against salmonellosis is of no value.

Pigs should not be fed uncooked swill or garbage, dead animals (for instance dead pigs, dead chickens), incubated eggs or contaminated meals.

4.2.4 Salmonellosis in sheep and horses

Infections of sheep with *S. abortus ovis* and horses with *S. abortus equi* may be of considerable economic importance under certain conditions. Both types have a strong tropism for the genital tracts of their definitive hosts. Human infections with them have never been clearly established. *S. typhimurium* infections are not infrequent in sheep in some countries, and infections with *S. choleraesuis* and *S. bovis morganii* have also been reported. Outbreaks in sheep caused by these types have sometimes resulted in spread to human beings.

4.2.5 Salmonellosis in other species

Practically every animal species investigated has yielded salmonellae. It is unwise to assume that a species is seldom or never infected until a thorough investigation has been made in different areas. Surveys made on *dogs* in recent years have shown an incidence of from 1% to over 30% in different areas, and over 50 types have already been isolated from them, including the ubiquitous *S. typhimurium*. The incidence has usually been low in European countries. Surveys on *cats* have already uncovered more than 20 types, incidence varying up to 12% according to area and conditions under which the animals lived.

4.3 Human and animal foods liable to contamination with Salmonellae

4.3.1 Eggs and egg products

4.3.1.1 Duck-eggs

Studies in Germany, the Netherlands and other countries have shown that a proportion of duck-eggs are contaminated with salmonellae, usually *S. typhimurium* and sometimes *S. enteritidis*. In England and Wales in 1954, a study indicated that 1.5 per thousand of the 126 million duck-eggs sold per annum at the time of the report were infected. Duck-eggs may be infected in the ovary or oviduct or through the shell. Improvements in farm hygiene would reduce contamination through the shell but the problem

of ovary and oviduct infection would still remain. Duck-eggs should be marked as such, and users of duck-eggs in the shell should be warned, for example by notices exhibited in shops selling the eggs.¹ There is merit in ensuring that duck-eggs are sterilized before the shell is broken as the use of raw duck-eggs in a kitchen may lead to the transfer of infection from the egg contents to lightly cooked or uncooked dishes via mixing bowls or washing-up water.

4.3.1.2 *Hen-eggs*

Though outbreaks of human salmonellosis due to hen-eggs *in the shell* are occasionally reported, they are rare.

4.3.1.3 *Egg products*

Egg products—dried whole egg, frozen whole egg, liquid whole egg, egg albumen and egg yolk—have been shown to be very important sources of salmonellae. Up to 20% of samples have recently been shown to be infected. Hen-eggs are usually contaminated from the shell. The use of clean, rapidly cooled first quality hens' eggs for the preparation of egg products would reduce but would not eliminate the risks, and the production of uniformly safe egg products requires pasteurization of the liquid before distribution. A temperature of 140°F or 146°F (60°C and 63.3°C) for three and two minutes respectively has been shown in laboratory and commercial practice to kill salmonellae in whole eggs without appreciably changing the qualities of the product. The temperature-range between killing the salmonellae and coagulating the egg is small, and careful control of the temperature is necessary (see Annex 4, page 65). With dried albumen a different process can be used. It can be heated to 128°F (53.3°C) for six days in bulk without reducing its usefulness to the baker or confectioner. In practice, three days are needed to raise the temperature of bulk quantities to the required level, and two days are needed for the containers to cool, so that the whole process occupies 11 days.

4.3.2 *Meat*

4.3.2.1 *Poultry meat*

That poultry can be a source of extensive food poisoning has been shown recently in the USA, where some hundreds of cases were associated with widely distributed pre-packed chicken salad contaminated with *S. blockley*. Roasted turkeys are frequently and chickens occasionally a source of infection in the USA, especially in institutions and schools.

¹ In the Netherlands, Germany and the United Kingdom, consumers are recommended to boil duck-eggs for 10-15 minutes before the shell is broken.

4.3.2.2 *Beef, veal and pork*

In some countries, the consumption of raw beef or veal is a common source of human salmonellosis, while in other countries, pork is more often incriminated. Boned beef and veal, pig liver, fresh and smoked sausages have been mentioned most frequently.

Sometimes human food handlers contaminate meat with salmonellae. Often contamination appears to come from infected animals. The infection may take place during shipment or in overloaded holding-pens at the abattoir, and extensive contamination of the meat may follow during the processing of the carcasses.

4.3.3 *Milk*

When milk is routinely pasteurized, the risk of its being a source of human salmonellosis is small, though a number of recent outbreaks have shown that the unhygienic bottling of pasteurized milk may be a danger. Outbreaks from unpasteurized milk occur from time to time either as a result of salmonellosis in a cow—*S. dublin* is often the cause—or as a result of the introduction of infection by food handlers. Milk products, in particular cheese, have sometimes been incriminated.

4.3.4 *Fish*

In temperate climates, cooked fish is seldom incriminated in food poisoning; where uncooked fish is eaten, however, salmonellosis sometimes occurs. In the warmer climates and where fish are caught in sewage-polluted waters, there are greater risks, and more observations are required before the problem can be accurately defined. Despite the well-known risk of typhoid and paratyphoid from shellfish gathered from sewage-polluted waters, there is little evidence of shellfish as vehicles of food-poisoning salmonellae, although such salmonellae have been isolated from the shellfish and the waters in which they live.

4.3.5 *Vegetable products*

The danger of contamination of vegetables and vegetable products in the field or afterwards by fertilizers, infected water or sewage should not be overlooked.

4.3.6 *Animal foods and fertilizers*

These products are being produced in many parts of the world from inedible offal and scraps from slaughterhouses, meat-packing plants, retail food dealers, etc., and from other raw materials, especially whole carcasses of animals that have died from disease.

Recently it has become known that they may be more or less heavily contaminated with salmonellae, including many uncommon serotypes. In some European countries it has been realized that after the import of such contaminated products, particularly fish-meal from Africa, salmonellae of types hitherto unknown in those countries have made their appearance in the animal and the human populations and have caused foodborne outbreaks in man.

Although in some countries fish-meals are produced in a manner that entails a heating process that will ensure the killing of salmonellae present in the raw product, some of the fish-meals heavily contaminated with salmonellae are being produced by milling sun-dried fish. Such fish is very liable to contamination from birds and rodents during the drying process. The introduction of more satisfactory methods of production in the countries concerned should be encouraged. Until such methods can be inaugurated, countries which have to import animal foods will have to consider the necessity for the re-sterilization of the products.

It has now also been shown that concentrates of vegetable origin (e.g., cotton-seed cake, sunflower cake, groundnut cake) and alfalfa may be contaminated with salmonellae. Further investigation is needed to determine the sources and degree of this contamination and the possibilities of sterilizing the products.

It is strongly recommended that in the plants where these foods and fertilizers are made there should be a strict separation between the "unclean" section where the raw materials are kept and the "clean" department where the sterilized meal is milled, sacked and stored, so as to prevent secondary contamination of the final product from the raw products. The meal should also be protected during storage against possible contamination from rats, mice, birds, reptiles and insects.

The introduction of salmonella-contaminated foods into factories which prepare mixed animal feeds may lead to contamination of mills and other equipment from which, in turn, other products may become contaminated. In this connexion the dangers of re-using sacks which have contained potentially contaminated material should be remembered.

4.4 Control of human salmonellosis

There is a lack of information on the true incidence of salmonellosis in man and animals in all countries. Careful investigation of outbreaks would improve knowledge of the nature and extent of the problem. Methods of investigation of human salmonellosis and of other types of food poisoning were given in the First Report of the Joint FAO/WHO Expert Committee on Meat Hygiene.¹ Experience has shown that in many outbreaks, even

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1955, 99, 8-11

when they are thoroughly investigated, it is difficult to trace the food or food ingredient responsible. Mention has already been made of cross-contamination of foods in kitchens and food factories. Where there are the necessary facilities, surveys should be made of foods or other substances which from their nature or method of handling might be contaminated.

So far as present knowledge allows the formulation of control measures, it may be said that they should include the following :

- (1) Reporting of cases so that they and their contacts may be prevented from spreading disease.
- (2) Education of caterers and food handlers in a high standard of kitchen and personal hygiene.
- (3) Proper refrigeration of foods.
- (4) Effective pasteurization of milk.
- (5) Hygienic production of eggs and storage in the cold if possible ; hygienic preparation of egg products, and effective heat treatment of the final product before distribution.
- (6) Sterilization of animal food liable to contamination.
- (7) High standards of abattoir hygiene.

These measures are self-evident and in many countries some attempts are being made to apply them. Heat treatment of food for animals has so far been very little used.

Pasteurization of egg products is being actively pursued at least on an experimental scale, but there are still problems to be overcome. The small difference between the temperature which ensures death of salmonellae and that which results in coagulation of the product raises difficulties when the method is applied commercially. There is need, too, for a test, such as the phosphatase test for milk, to ensure that the pasteurization method is being used effectively. Despite the difficulties health authorities should press for legislation to ensure that egg products free from salmonellae are distributed. It is impossible to measure the contribution made by egg products to human salmonellosis, but they are so widely used in "dangerous situations"—bakeries, confectioneries, cooked-meat factories and the like—that they may well be a major source of trouble even though it has been found difficult to trace specific outbreaks to this source.

The main food source of human salmonellosis, however, is meat. Therefore, the importance of a high standard of hygiene in abattoirs and meat-packing plants cannot be over-emphasized. Rapid and adequate cooling of carcasses (preferably below 10°C (50°F) is essential. This applies also to edible offal which is going to be packed in barrels or boxes for further handling.

It has been shown by more than one investigator that while cattle and pigs fed with salmonella-contaminated foods or otherwise naturally infected do not necessarily show illness, their organs may contain salmonellae. During the processing of their carcasses in the abattoirs widespread contamination of the meat passing through the abattoir can occur. At least one very large human epidemic in recent years originated in this manner, and no doubt abattoir contamination of meat has caused many other outbreaks. Health and veterinary authorities should ensure the hygienic operation of abattoirs by demanding the application of all possible sanitary measures¹ including bacteriological checks. Food-processing plants should also be subjected to similar precautions and control procedures. It is the responsibility of the food industry itself to develop the use of bacteriological methods in the sanitation of food processing. In some countries this is already regulated by the government.

When widely-distributed foods have been freed from salmonellae, the problem of human salmonellosis will have to be reassessed and it will then perhaps be possible to define the role of the human symptomless excretor in the food factory and kitchen.

In the investigation of salmonellosis, full use should be made of the resources of national and international salmonella centres (see Annex 5, page 66).

5. LEPTOSPIROSIS

5.1 Epidemiology

Leptospirosis occurs in animals and man in all parts of the world. The epidemiology of the disease follows a characteristic pattern, similar to other zoonoses, animal to animal, and animal to man. The chain of transmission, with rare exceptions, stops with human infection.

For many years rats and field-mice, and later dogs, were considered to be the primary animal carriers, but, as investigation increased, a wider host range was uncovered, not only among domestic animals but in a variety of wild mammals. Leptospirosis now constitutes a major problem in cattle and a problem of undetermined size in swine. In some areas sheep, goats and horses become infected. Rodent carriers include rats, mice and voles. In addition, bats, mongooses, bandicoots, shrews, hedgehogs, jackals, foxes, opossums, raccoons, skunks, wildcats and others have been found infected. In these host animals, leptospirae become localized in the kidneys and may be found in the lumen of the convoluted tubules. They are shed in the urine often for long periods. Arthropods do not seem to have much importance but some ticks can remain carriers.

¹ See *Wld Hlth Org. techn. Rep. Ser.*, 1955, 99.

Some leptospiral serotypes have a single animal host, others may infect a variety of hosts. Sometimes more than one type may be found in the same host. An example of this is *L. canicola* found principally in dogs; it has been isolated from cattle, swine and jackals, while dogs have been found to harbour at least nine other serotypes.

The dispersion of leptospirosis is related to specific environmental conditions, particularly those which bring animal carriers, water, mud and man together. Animal carriers often excrete a profusion of leptospires in the urine—up to 100 million per ml. If the urine is excreted into water or mud which is neutral or slightly alkaline the leptospires may survive for weeks. Susceptible animals and men entering this environment are exposed to the agent and may develop infection, varying from an inapparent response to an acute fulminating fatal disease.

The leptospires usually enter the body through the mucous membranes of the conjunctivae, nose or mouth, or the broken or macerated skin. It is doubtful if these organisms can penetrate the intact skin, and it is unlikely that the stomach or intestines are important portals of entry since the pH of the stomach or rumen is such that they are rapidly killed.

5.1.1 Human infections

In man, Weil's disease caused by *L. icterohaemorrhagiae* is still the most dangerous of the leptospiral infections, but serious human infections caused by other serotypes of leptospires also occur, for example, fatal cases have been reported from infections caused by *L. bataviae*, *L. grippotyphosa*, *L. pyrogenes* and a few other serotypes. Although other serotypes may cause a relatively mild disease, recovery usually takes a long time and occasionally complications may occur later. In cases of an acute disease with high fever and signs of muscle pains, redness of the conjunctivae, and jaundice, and in cases of aseptic meningitis, the possibility of leptospirosis must be considered. Early laboratory investigations to confirm the diagnosis should be carried out especially where occupational exposure to infective material is suspected.

The disease has long been recognized among veterinarians, slaughter-house workers, canal workers, poultry and fish handlers, kennel men, swineherds, miners, packing-house employees, plantation labourers and others. In Weil's disease individuals in contact with water contaminated with urine from infected rats are at special risk. Workers in irrigated fields (rice and cane fields, in particular) often become infected, as do farmers handling infected livestock, particularly swine and cattle, while owners of dogs have suffered from the disease.

For many decades swimming and accidental immersion have been associated with Weil's disease in humans, but in recent years other serotypes have been shown to cause disease after such exposure to contaminated

water. In the USA four such outbreaks have been reported. These episodes followed a common pattern. They occurred in the late summer during dry periods (stagnant ponds or slow-moving streams) when there was presumed contamination of the water by urine from infected animals. Most of the infections were characterized by signs of meningitis. Children and young adults were principally involved.

5.1.2 *Cattle and swine*

Leptospirosis is thought to be spread by contaminated water and soil, by chronic shedders among domestic animals, and probably by wild animals in some areas. The disease is known to spread very rapidly in feeder cattle, dairy herds and swine. In cattle there have been instances of epizootics extending over many counties. Infection in cattle and swine can result in abortion. Mortality in calves is heavy in some parts of the world.

5.1.3 *Dogs*

The disease is spread from dog to dog by urine, by direct contact, or by contaminated fomites, as well as by water. In some cases it can be spread from rodents or livestock to dogs; it is frequently epizootic in dogs in urban populations. The epizootic may persist for some months before subsiding, and after such an episode the disease may not reappear for years.

Despite widespread infection of dogs with *L. canicola*, surprisingly few cases in man ascribable to this source have been observed.

5.1.4 *Rodents and other small mammals*

Widespread infection in these animals is an important source of disease for domestic animals and man.

5.2 **Laboratory diagnosis**

The principal methods used for diagnosis are culture, animal inoculations and serological tests. All these methods should be used wherever possible, although serological tests are the most widely employed because of their practicability.

The agglutination test ¹ is the method of choice, but it has some practical disadvantages in that antigens are frequently unstable, and a large battery of antigens made from different serotypes is required to cover the spectrum

¹ This test has been known as the agglutination-lysis test. Recent work with the aid of the electron-microscope has revealed that true lysis does not occur.

of serotypes found in a particular area. This difficulty can partially be overcome by grouping related serotypes into antigens or mixtures of antisera which can be used for screening purposes.^{1, 2}

For diagnostic purposes in individual cases of illness, the most significant finding is a rising titre in two serum specimens taken 7-8 days apart, provided that the first is taken early in the course of the disease. On single specimens no definite statement can be made, but a relatively high titre found in conjunction with clinical signs is presumptive evidence of leptospirosis. Some workers have reported low levels or absence of antibodies when antibiotics have been administered very early in the disease, or when the case is rapidly fatal.

When making serological surveys it should be borne in mind that the length of time for which antibodies persist, and the height of the titres, vary both in different individuals and with the serotype causing the original infection. Microscopic screening tests in animals with both living and killed antigens can be carried out at a single serum dilution of 1/100, and a positive reaction at this dilution can be considered as evidence of past or present infection with leptospire.

Complement-fixation tests are used by many workers for diagnosis, but this type of test is inferior in value in most instances to the agglutination test.^{3, 4, 5} Some workers have obtained favourable results with Cox's hemolytic test⁶ but this test has not yet been evaluated on a large scale.

Isolation of the leptospire by culture or animal inoculation should be tried whenever possible.^{3, 4, 5}

5.3 Classification, typing and nomenclature

The Committee read the report on diagnosis and typing in leptospirosis⁴ of a Study Group convened by WHO, with FAO participation, in November 1955. Work carried on by members of the Study Group and collaborating laboratories since that time, including meetings of some Panel members in December 1957 and during the Seventh International Congress for Microbiology immediately preceding the present meeting, was also brought to the attention of the Committee.

¹ Alston, J. M. & Broom, J. C. (1958) *Leptospirosis in man and animals*, Edinburgh, Livingstone Ltd., table 34, p. 309

² Galton, M. M., Powers, D. K., Hall, A. D. & Cornell, R. G. (1958) *Amer. J. vet. Res.*, **19**, 505

³ Alston, J. M. & Broom, J. C. (1958) *Leptospirosis in man and animals*, Edinburgh, Livingstone Ltd.

⁴ *Wld Hlth Org. techn. Rep. Ser.*, 1956, 113

⁵ Wolff, J. W. (1954) *The laboratory diagnosis of leptospirosis*, Springfield, Ill., Thomas

⁶ Cox, C. D. (1957) *J. infect. Dis.*, **101**, 203

It was noted that the *Leptospira* Subcommittee of the International Committee on Bacteriological Nomenclature at its meeting during the Seventh International Congress for Microbiology had considered various recommendations made by the Study Group on questions of classification and typing of *Leptospira* and had accepted most of them. The following views in this section of the report, therefore, represent the opinion of the present Committee which, except for relatively minor points, is in fundamental agreement with the groups mentioned previously.

5.3.1 *Classification and typing*

The current scheme of classification which divides the genus *Leptospira* into serotypes on the basis of agglutination characters, by agglutination and cross-absorption reactions with immune rabbit sera, still provides the best system available.

In view of the paucity of basic information on the nature of agglutinating antigens, and in view of the large number of serotypes that could be envisaged if serotypes were to be distinguished on the basis of minor differences, the Committee considers that some arbitrary numerical standard must be applied for the official recognition of different serotypes. The criterion most widely accepted at present is the residual homologous titre after cross-absorption (see below), and arguments have been advanced for (a) reducing the presently accepted 10% figure to 6%, which would enlarge the number of recognized serotypes, or (b) increasing to 25%, which would reduce the number. Since the 10% figure has been widely used for many years, and there seem to be no compelling reasons in the light of our present incomplete knowledge on antigenic composition to change this figure, the Committee recommends the following criteria for classification.

5.3.1.1 *Serotype*

Two strains are considered to belong to different serotypes if, after cross-absorption with adequate amounts of heterologous antigen, 10% or more of the homologous titre regularly remains in each of the two antisera in repeated tests.

5.3.1.2 *Sub-serotype*

In some instances residual titres lower than 10% may occur, and if these findings are constant these strains may be grouped within the serotype as sub-serotypes. Thus a sub-serotype is a strain within a serotype where in repeated tests less than 10% of the homologous titre remains in one antiserum but 10% or more in the other antiserum after cross-absorption with adequate amounts of heterologous antigen (within the serotype).

5.3.1.3 Serogroup

This is a group of two or more serotypes showing marked similarities in their serological reactions by the agglutination test. It should be noted that for routine diagnostic purposes detailed serological analysis of isolated strains is not necessary, and a preliminary classification by means of simple agglutination tests using a battery of standardized antisera will suffice. By this technique, strains of pathogenic leptospirosis can be grouped (serogroup) into *icterohaemorrhagiae*, *grippityphosa*, *pomona*, etc.

Annex 6 (see page 70) shows the classification according to the above-mentioned criteria. The Committee fully realizes the fact that biochemical methods of antigenic fractionation of leptospires, or other methods, may in the future provide a new and more satisfactory basis of differentiation and classification.

In view of the increasing number of "new" serotypes which are appearing in the literature without adequate description of serological characteristics, the Committee suggests that before a new serotype be accepted as valid, either the work should be verified in one of the WHO/FAO Leptospirosis Reference Laboratories (see Annex 7, page 72), or, if the work had been done in a Reference Laboratory, the protocols of agglutination and agglutinin-absorption tests should be examined by a second Reference Laboratory.¹

The Committee notes with satisfaction the valuable functions being fulfilled by the six WHO/FAO Leptospirosis Reference Laboratories in assisting countries with respect to the classification and typing of strains, the fostering of uniform methods for diagnosis and surveys, and research on improved laboratory procedures. The Committee strongly recommends that countries take full advantage of the services offered by these centres, and that WHO and FAO continue to assist their work (see Annex 7, page 72).

¹ At the Seventh International Congress for Microbiology in Stockholm in August 1958, the Leptospira Subcommittee recommended that the terms *L. icterohaemorrhagiae* (AB) and *L. icterohaemorrhagiae* (A) (or such designations as complete and incomplete biotypes or sub-serotypes) be no longer used to designate the two sub-serotypes of *L. icterohaemorrhagiae*. This should also apply to serotypes (e.g., *L. australis* A and *L. australis* B). No alternative method of designation was, however, proposed. A reasonable solution would be the adoption of the system outlined in the International Code of Nomenclature of Bacteria and Viruses (Iowa State College Press, Ames, 1958) for the designation of taxa of subspecific status. The Leptospira Subcommittee also decided for the present against a proposal that the names of all leptospiral serotypes be latinized. However, if at some future date the present serotypes be accorded specific rank, then the names must be brought into conformity with the Code. This would mean that any specific, or subspecific, epithets correctly formed and validly published would automatically have priority over names not in latinized form, even if these had been in use for many years and were well established in the literature. To prevent confusion which might result from changes at a later date, the Committee recommends that this be again brought to the attention of the Leptospira Subcommittee for further consideration of the question.

5.4 Prevention and treatment of leptospirosis

5.4.1 Prevention

In the prevention of leptospirosis the animal shedder, the contaminated environment and the exposed individual or animal have each to be considered.

(a) *The animal shedder.* Small rodents, particularly rats and mice, are the principal spreaders of leptospirosis contracted in fields (Weil's disease, mud fever, cane fever, etc.) and from bathing pools, although large-animal reservoirs are sometimes concerned in the latter. The pig shedder has often been the source of human infections through contact, and cattle and dogs to a much lesser extent.

Cattle infected with *L. grippotyphosa* and *L. pomona*, and dogs infected with *L. icterohaemorrhagiae*, however, can be dangerous sources of infection.

There has been little success in achieving a practical method for eliminating the shedder state in animals through antibiotic treatment. This point is important and the Committee recommends that further research be carried out.

Rodent spreaders can be combated only by rodent control. This is difficult to accomplish economically in the agricultural areas usually affected by leptospirosis. Some partial success was recorded in Italy and Spain where a Dicumarol-type compound was used in poison baits in the campaigns, but this method required renewed efforts yearly on large tracts of land, and the economic and health benefits were not sufficient to encourage routine use. In Australia the burning of cane-fields has achieved limited success. A thorough knowledge of local rodent ecology is necessary to ensure success and this information is often lacking.

(b) *Contaminated environments.* Leptospire are very sensitive to disinfectants, and chlorine disinfection of water or bathing pools should be carried out wherever possible. The disinfection of contaminated barns, pigsties, etc., can be accomplished with the common disinfectants, for example cresols.

Disinfection of large tracts of land, such as rice-fields, with copper sulfate or calcium cyanamide has been tried but results have not been successful except under limited and special conditions (as in some areas of Japan).

(c) *Prophylaxis in man and vaccination of animals.* Protective clothing such as boots and gloves are to be recommended for hunters, fishermen and sewer-workers, but they are impractical for field workers, miners and other vulnerable groups. Protective skin creams have been tried; they offer some protection but only for a short period.

Vaccination has been claimed to be successful in Italy, Spain, Japan and the USSR, but it is often difficult to evaluate the claims because the numbers of persons under observation were insufficient to give statistical significance to the differences between vaccinated and unvaccinated groups. Also, some vaccines have caused undesirable side-reactions and have been abandoned. The best results seem to have been achieved in Italy where formolized or merthiolate vaccine was used. Two subcutaneous inoculations of 1 ml of concentrated vaccine 7-10 days apart were given.¹

Chemoprophylaxis has been recommended for use after an outbreak has started, where multiple serotypes are incriminated in a region, or where anticipated exposure will only be of short duration, but the Committee had insufficient data to evaluate this procedure.

The Committee also found it difficult to evaluate claims for the effectiveness of vaccines in animals because sufficient experiments had not been reported. Some vaccines in dogs (prepared with *L. canicola* and *L. icterohaemorrhagiae* serotypes) and in cattle (prepared with *L. pomona*) have apparently protected to some extent against clinically demonstrable disease, but in many instances have failed to protect against the establishment of a carrier state within individual animals. This is a serious drawback from the public health point of view. The Committee strongly recommends that carefully controlled experiments be carried out with vaccine in domestic animals to enable a better assessment to be made of the value of vaccines for these animals.

5.4.2 Treatment

Early serotherapy of Weil's disease in man, using purified antiserum of high potency, has given excellent results. Penicillin has been the antibiotic most commonly employed in the treatment of acute leptospirosis in man. Contradictory results have been obtained by different workers. Treatment, if given early in the disease before the sixth day of illness, has been claimed to reduce the pyrexial period with quick improvement of the patients. Herxheimer's reactions, followed by rapid relief of symptoms, have sometimes been observed, but opposed to these observations have been careful studies of treated and untreated individuals with no significant differences in the results. These failures were noted particularly in infections caused by *L. icterohaemorrhagiae* and may not apply equally to infections caused by other serotypes.

Conclusive results have not been obtained with antibiotics (streptomycin, penicillin, tetracyclines) in infected animals, although favourable responses have been reported in cattle and dogs treated early after infection.

¹ Babudieri, B., Bussinello, E., Bajocchi, E., Salvi, A. & Massa, L. (1955) *Riv. Infert. Mal. prof.*, **42**, 453

6. TUBERCULOSIS OF ANIMAL ORIGIN

6.1 Bovine tuberculosis

Eradication of bovine tuberculosis is a major objective of a number of countries. Considerable progress has been made in the eradication of tuberculosis in cattle in many parts of the world since the Report of the First Session of the Joint WHO/FAO Expert Group on Zoonoses was published.¹ This is exemplified by the present position not only in Norway, Sweden, Denmark, Finland and the USA, which were already well forward at the time of the first report and are now free of the disease or practically so, but also in Canada, the Netherlands, Switzerland, Great Britain and the Federal Republic of Germany, in all of which rapid results have been obtained by the application of the methods of control recommended by the Group (see Annex 8, page 73), the basis of which is the systematic application of the tuberculin test and removal of reactors. The continuing decrease of the incidence of tuberculosis in cattle is being accompanied by a great reduction in the incidence of bovine tuberculosis in the human population and, in some countries, its virtual elimination.

So far as is known, the kinds of tuberculin and methods of application given in the first report have in the main been continued in the different countries.²

While different types of tuberculin are used in different countries, purified protein derivative (PPD) is considered to be the tuberculin of choice because of its state of comparative purity (tuberculo-protein) and the ease with which it can be standardized. In the production of tuberculin, strains of the human type of the tubercle bacillus are largely used. In some countries bovine strains are regarded as more specific; the evidence on this point, however, is by no means conclusive.

In the retesting of cattle, the interval between the application of tests varies according to the position of the disease in the herd: thus, when reactors are still present in the herd, an interval of about 60 days (not less) should elapse between tests while, on the other hand, when no further reactors are demonstrated the interval may be increased to several months and eventually to a year or more. Retesting with tuberculin, however, even in herds in which no reactors exist, is essential to detect possible introduced infection.

Non-specific reactions (reactors with no visible lesion) to the tuberculin test continue to be a problem, especially in some countries. The incidence

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1951, 40

² The doses of purified protein derivative (PPD) tuberculin used in Great Britain, however, have been changed. They are now: *mammalian* tuberculin 10 000 international units (IU) (0.1 ml tuberculin, 2 mg per ml); and *avian* tuberculin 2500 IU (0.1 ml tuberculin, 0.5 mg per ml).

of non-specific reactions increases in importance as that of tuberculosis becomes less in herds and areas. While some of the causes of this sensitivity to tuberculin are known, and differentiation between such sensitivity and that caused by bovine tuberculosis can often be made, for example, by the use of the comparative tuberculin test (mammalian and avian tuberculins), more work is still necessary on the causes of non-specific reactions. Epidemiological and laboratory studies that may reveal ecological and other factors to explain the sensitivity to tuberculin tests, such as those being co-ordinated by the Tuberculosis Research Office of WHO, are to be encouraged. These findings would be of value towards solving both human and veterinary problems pertaining to tuberculin reactions.

Animals can also, of course, become infected from man, and a large number of reinfections of tuberculin-free herds with human- or bovine-type strains have been traced to this source.

Infection with human strains does not cause progressive lesions in cattle but often gives rise to a marked tuberculin reaction, frequently temporary in nature, and interferes with the application of the tuberculin test.

Tuberculosis in buffaloes is a problem in some countries. While, generally speaking, its control and eradication may be practised on lines similar to those for tuberculosis in cattle, some further work is necessary on the application and interpretation of the tuberculin test in these animals.

In the human being, vaccination against tuberculosis is being extensively practised in some parts of the world. In cattle, experiments have been made with vaccines consisting of live cultures of the BCG and vole strains of the tubercle bacillus. The Committee is of the opinion that, generally speaking, vaccination has no place in the eradication of tuberculosis in cattle. The method has never been shown to lead to the eradication of the disease; vaccines such as those composed of BCG or the vole strain of bacilli create a sensitivity to tuberculin, and therefore interfere to a marked extent with schemes for eradication of the disease in which tuberculin testing forms the basis. Many difficulties are inherent in the application of any vaccination scheme, one of the most important being the essential condition that only animals free from the disease are submitted to vaccination.

While in man chemotherapy may be a useful asset in dealing with tuberculosis, it has no place in animals and should be discouraged. In addition to the possibility of the development of resistance of strains of the causal organism in treated animals, the use of chemotherapy is entirely impracticable in animals because of the high cost of treatment and the frequent recurrence of the disease when treatment is stopped.

Tuberculosis in man resulting from bovine organisms was a serious problem in the past in several countries, and the reduction in human cases which follows the reduction of tuberculosis in bovines has been

clearly demonstrated. Typing should be encouraged in a country in which the necessary information is not already available.¹

6.2 Tuberculosis in animals other than cattle

Animals other than cattle may occasionally be a source of infection for man. *Monkeys* are the most important; they are highly susceptible to both human and bovine types and can transmit the disease to their attendants. *Dogs*, though moderately resistant, can contract infection with either human or bovine organisms, the proportion in any area depending on the type of exposure; in the main, human sputum, bovine milk and possibly meat. *Cats*, which are highly resistant to the human type but susceptible to the bovine type, are also a possible hazard, though contact with man is usually less close than is the case with dogs, especially lap-dogs. *Parrots* are susceptible to the human type and may be a particular danger owing to their intimate contact with human beings. *Goats* are susceptible to the bovine and human types but are not commonly infected. Several records of infection of clean bovine herds from goats are in existence. *Pigs* are frequently infected, prevalence being greater in sows and boars than in younger pigs. The type concerned—bovine and avian usually, but sometimes human—depends on the nature of the exposure. They constitute only a minor hazard to man and indeed apparently to cattle in contact, though infection of cattle from pigs has been clearly established. *Horses* are sometimes infected but constitute a negligible hazard, and *sheep* are rarely infected.

7. ANTHRAX

Though the number of reported cases of anthrax, both human and bovine, is relatively low when compared with the other zoonoses, these data give a false impression of the true importance of the disease. From available published data the number of human cases occurring annually has been estimated to be about 9000. Most of these cases occur in people living in rural districts, but in some areas industrial infections are frequent. When various reasons for under-reporting are taken into consideration, a truer incidence figure is felt to be somewhere between two and ten times the reported figure.² The impact of anthrax upon the animal husbandry economy may be estimated as the sum of the total cost of yearly immuni-

¹ World Health Organization (1953) *Advances in the control of zoonoses*, Geneva (World Health Organization: Monograph Series, No. 19)

² This estimate is based on studies made in both economically advanced and less-developed regions. For example, in certain African countries reporting few cases annually, up to 20 times this number was observed in individual clinics and hospitals.

zation and the economic loss due to animal deaths. This sum is very considerable because in many countries annual vaccination campaigns affecting much of the livestock population are required. Epidemiologically the problem can be conveniently divided into its agricultural and industrial aspects.

7.1 Agriculture

The spore form of *Bacillus anthracis* is very resistant to chemical and environmental influences and can survive for years in certain soils and in animal products such as hides, hair and wool. When anthrax infection in livestock becomes established in a district, a relatively permanent enzootic focus of infection is created because of the inability of the soil to destroy the spores. Heavy contamination of the soil exists in many areas of the world, particularly in Asia, Southern Europe and Africa. Other countries have large or small "anthrax districts", but the anthrax problem is not as serious in the western hemisphere as it is in other parts of the world.

There is considerable evidence to show that anthrax is introduced into some countries by feeding-stuffs and fertilizers prepared from bones and other products of animals that died of anthrax. Non-infected materials may also become contaminated during transport in vehicles or ships which have recently conveyed infected bones, hides, or hair. Contamination of agricultural areas may occur through the use of waste materials salvaged from wool- and hair-processing plants as fertilizer material on crop lands, or by the effluents from plants such as tanneries.

The anthrax bacillus can also be spread by flesh-eating birds, animals and insects from carcasses to healthy animals.

The main source of infection in agricultural workers is contact with contaminated carcasses, wool, hair and hides. The ingestion of insufficiently cooked meat derived from infected animals is another source of infection. Inhalation anthrax is now rare.

Many factors contribute to the frequency of anthrax infection in man. Despite the familiarity of farmers with anthrax in livestock where this disease recurs periodically, the onset of an epizootic is frequently difficult to recognize because of the lack of striking signs in the hyperacute or apoplectic form of the disease which may be found at the beginning of an outbreak. For economic reasons, farmers are loath to lose the value of hides which are salvaged from dead animals, even where anthrax is recognized as the cause of death. Animals are often slaughtered at the first sign of any illness for meat purposes as well as for their by-products. These practices are highly dangerous.

Regulations are helpful in areas practising advanced animal husbandry, but in some communities these regulations must be abetted by concrete

assistance from governmental authorities, in the form of low-cost or free vaccination programmes in livestock, undertaken at regular intervals. In anthrax, therefore, as with other zoonoses, the responsibilities of the health and agricultural authorities are interlocked, and the following steps for control of this disease are recommended :

(a) The provision of adequate local facilities for the diagnosis of anthrax in animals. Rapid presumptive diagnoses can be based upon bacteriological smears made directly from the dead animal or upon the performance of the Ascoli precipitation test (see Annex 9, page 77). Where facilities are available, culture and animal inoculation procedures should be used.¹

(b) The unopened carcass of the animal dead from anthrax, or in which anthrax is suspected, should be destroyed at the site where the animal died as soon as possible after death. The preferred method is by incineration ; however, if this is not possible, burial with lime spread over the carcass in a pit two metres deep is effective in preventing spread of the organism from the contaminated carcass.

(c) Subsidized livestock-vaccination programmes undertaken at regular intervals, using biological products of proved potency. Experience has shown that annual vaccination is necessary, and in some badly affected areas vaccination every six months may be needed.

Many different kinds of anthrax vaccines (particularly spore-suspension) have been used successfully for the prevention of this disease in animals ; the Sterne vaccine has been used with considerable success in many countries.

(d) Education of the agricultural population in the early signs of this disease in man and animals. Emphasis should be placed on the dangers of contaminated wounds, scratches, and abrasions, and of eating meat from infected animals ; the necessity for proper handling and disposal of carcasses should also be stressed. Suspected cases of anthrax in animals should be promptly reported to the responsible authority.

When anthrax has been diagnosed within a herd it is advisable to quarantine the entire herd for a period of two weeks after the last diagnosed case of anthrax, or two weeks after effective immunization. The quarantine implies that none of the animals, either singly or as a herd, can be moved from the premises or pastures where they were at the time of the diagnosis.

(e) The management of anthrax in dairy herds has been well covered in the first report of the Joint FAO/WHO Expert Committee on Milk Hygiene² as follows :

¹ The use of anthrax gamma bacteriophage, which is specific for *B. anthracis*, makes it possible to confirm the diagnosis of anthrax usually within 12 hours after the animal tissues have been received at the bacteriological laboratory (Brown, E. R. & Cherry, W. B. (1955) *J. infect. Dis.*, **96**, 34).

² *Wld Hlth Org. techn. Rep. Ser.*, 1957, **124**, 14

"Fortunately, cattle infected with anthrax do not usually excrete the bacillus in their milk since milk secretion stops abruptly. However, the danger of milk contamination arises from the environment which frequently is highly contaminated with the bacillus or its very persistent spores.

"Where anthrax actually exists in a herd, great precautions must be taken because of the possibility of the environmental contamination of the milk (warm milk provides a good medium for the multiplication of the anthrax bacillus and the formation of spores). Despite this danger, however, milk-transmitted anthrax has been very rare.

"Where adequate veterinary supervision is available and good sanitary practices are followed, precautions should include the careful observation of all animals in the herd for a period of at least two weeks after the last-observed clinical case of anthrax. During this period, any animal showing signs of illness (including a rise in temperature as indicated by a daily thermometer check) should be isolated and its milk excluded from the remainder of the supply. The rest of the milk from well-supervised herds of this kind should be pasteurized or otherwise adequately heat-treated.

"In all instances of anthrax infection in a herd, thorough disinfection of the premises should be a requirement.

"Another point of difficulty in connexion with milk hygiene aspects of anthrax occurs where dairy herds are inoculated with living-spore vaccines, with the resultant possibility of anthrax bacilli being excreted in the milk. Despite the lack of evidence of this possibility materializing, certain authorities have recommended that milk from herds where spore vaccine has been administered be not used for 3 to 30 days following administration. This often produces a decided hardship for farmers and very frequently the application of such a restriction is not practicable. A more workable procedure would be to require that all milk originating from vaccinated herds be subjected to adequate heat-treatment before consumption, and that no milk should be used from animals showing systemic reactions to the vaccine (fever, anorexia or other clinical signs). (The difficulty can be avoided entirely if the animals are vaccinated when dry.)"

(f) The recognition or suspicion of anthrax in a carcass in an abattoir calls for severe measures. Operations should cease until rapid presumptive tests (smears, Ascoli precipitation test) are made. If these are positive, the infected carcasses and all carcasses possibly exposed to contamination should be sterilized, and thorough disinfection (2% lye) of the contaminated premises should be performed before operations are resumed. In well-run abattoirs such incidents occur only rarely, because animals ill with anthrax would usually be recognized at ante-mortem inspection.

7.2 Industry

Cutaneous infection caused by contact with contaminated animal by-products (wool, hair, hides, skins) is by far the most frequent form of anthrax encountered in industrial workers. The inhalation form of anthrax rarely occurs, although health authorities should be on the alert for focal epidemics of this type.¹

¹ An outbreak of inhalation anthrax occurred in the USA in 1957, when several cases of inhalation anthrax were reported from among the employees of one industrial concern within a few weeks.

The principal sources of anthrax in industrial workers are two groups of animal by-products : (a) hair and wool, and (b) hides and skins. Nearly all cases of anthrax from handling contaminated hair and wool occur in procedures taking place before the weaving and finishing operations ; the spore does not usually survive the dyeing process. Anthrax associated with hides and skins occurs from handling of these materials before the tanning and finishing operations. Goat hair and skins from areas where anthrax is highly enzootic are the greatest sources of human infection. The most dangerous wools are coarse wools originating from countries and districts where anthrax is a severe and continuing problem. "Grease" wools, even from areas where anthrax is highly enzootic, are not as contaminated with *B. anthracis* spores as are "pulled" wools, since these latter wools may have originated from animals dead from anthrax.¹ "Grease" wools may, however, become contaminated during handling.

Wool that is used in manufacturing carpets (coarse wool) is associated with more human anthrax infections than is the fine wool used in the manufacturing of textiles. The danger is considered to be diminished after the scouring process which will reduce the content of dirt and extraneous material as well as cause some reduction in the number of *B. anthracis* spores adhering to the wool. The dyeing of wool in its raw state also reduces the danger of anthrax infections.

Control recommendations should be made with the object of disrupting as little as possible the supply of raw materials, and should not involve a cost out of proportion to the seriousness of the problem.

There are many advocates for the compulsory disinfection of animal products potentially contaminated with *B. anthracis*. From an economic point of view, there is no known satisfactory inexpensive method of disinfecting hides and skins, or of treating effluents from factories. For hair and wool there is an effective process of disinfection in current use in the United Kingdom (see Annex 10, page 78). This process makes it possible to reduce the contamination of the raw wool and hair with *B. anthracis* and thus decreases the likelihood of anthrax infections occurring among those who subsequently handle these materials. Because of the expense of this method of disinfection, its cost should be subsidized by governments or spread evenly among the entire industry.

The procedures recommended in plants where potentially contaminated materials are handled are dealt with in Annex 11 (see page 78).

¹ "Grease" wools are obtained by cutting or clipping wool from the live animal and are baled and shipped in the natural greasy condition. "Pulled" wools, also called "skin" or "dead" wools, are obtained from the skins of dead animals. The wet processes used in the removal of "pulled" or "dead" wool from the skin, and in the washing or scouring that frequently follows, may result in the spread of the micro-organism to previously uncontaminated wools.

7.3 Infections from bristles

In the past, numerous cases of anthrax in man have been caused by bristles of shaving-brushes and certain other brushes contaminated with anthrax spores. It is recommended, therefore, that all bristles to be used for shaving-brushes be subjected to a sterilization procedure before being embedded in the handle.

7.4 Importation of animal by-products

Animal by-products, such as wool, hair, hides, skin, bones, bone-meal, etc., are frequently contaminated with *B. anthracis* and serve as vehicles for introducing the disease into countries which import these materials. It would be difficult to formulate uniform regulations which could be applicable to all countries. The Committee feels, however, that certain measures in connexion with import requirements are practicable and have proved useful in the past, and suggest as a guide the regulations now in effect in the United Kingdom (see Annex 12, page 80).

7.5 Vaccines for humans

Another control measure which can be considered for prevention of human anthrax is the use of an anthrax vaccine for protection of all individuals who have contact with potentially contaminated materials. Various vaccines for use in humans have been prepared and administered to exposed groups. These are discussed in reports from the United Kingdom,¹ the USSR,² and the USA.³ Promising results have been claimed for these vaccines.

7.6 Therapy

Before the advent of sulfonamides and penicillin, even the cutaneous form of anthrax had a mortality rate of up to 20%. Early diagnosis and treatment with penicillin or other broad-spectrum antibiotics have currently reduced the mortality of the cutaneous disease to almost zero. Successful results with penicillin treatment and broad-spectrum antibiotics have also been obtained in animals.

¹ Darlow, H. M., Belton, F. C. & Henderson, D. W. (1956) *Lancet*, **2**, 476

² Shliakhov, E. N. (1957) *J. Microbiol. Epidem. Immunobiol.*, **28**, 748

³ Wright, G. G., Green, T. W. & Kanode, R. G., jr (1954) *J. Immunol.*, **73**, 387

8. PSITTACOSIS-ORNITHOSIS

Psittacosis is a generalized infection of man or psittacine birds by one of the psittacosis-lymphogranuloma group of organisms. Ornithosis is the term used for the same infection in birds other than psittacines. Some 100 species of birds of which more than one-half are psittacines have been found to be naturally infected. Emphasis on the psittacine aspect of this disease has recently been replaced by interest in the infection of poultry as a public health and economic problem. Acute ornithosis is at times a severe disease of turkeys, ducks and pigeons.

8.1 Epidemiology

The psittacosis-lymphogranuloma group of organisms is one of the most widely disseminated in nature. It is found in many varieties of birds, animals and man. Fortunately, it is usually of low virulence and only occasionally produces disease in man or its host.

Psittacine birds have been recognized as the primary source of disease for man in the past. Most infections have occurred in persons having close contact with them—bird breeders, handlers, sales persons, fanciers, and pet owners.

Turkeys, and to a less extent pigeons and ducks, are also a major source of infection for man. Disease from these sources has been reported among farmers, poultry processors, and rendering plant workers. Some of these individuals have been infected more than once. No disease has been traced to the consumption of poultry or poultry products. Pigeons are a world-wide source of infection for man, especially among pigeon fanciers and handlers. Most infections are mild, although some severe cases have been reported.

In areas where psittacosis exists in wild or domestic birds, few people can avoid direct or indirect contact with this source of infection. Fortunately, few individuals develop disease, although a number show serological evidence of past infection. It is thought that mild inapparent infections of avian origin, without pneumonitis or any recognizable symptoms, have been the cause of most of these positive serological reactions. It is improbable that the mammalian viruses of the psittacosis group were the source of these infections except among certain groups, such as veterinarians and livestock handlers.

The public health hazard of free-flying pigeons in urban areas, as well as starlings and sparrows, is relatively small, although in some areas they have been incriminated as being the source of human disease. They have probably been the source of many of the inapparent infections.

The mammalian reservoirs of the psittacosis group are becoming increasingly important as an animal health problem. The public health significance is very small. Few human infections have been attributed to this source, except among some individuals exposed to enzootic abortion of ewes.

It has been suggested that man may be the primary host of certain strains of the psittacosis organism—for example, the San Francisco, Illinois and Louisiana strains—and also that there may be certain human strains that are of less virulence than those mentioned which generally cause no more than a mild respiratory infection. These views require further confirmation.

8.2 Diagnosis ¹

8.2.1 *Virus demonstration*

In man, diagnosis is confirmed by the isolation of the virus from the blood or sputum. This is often difficult to accomplish and requires repeated attempts. In patients treated with antibiotics isolation of the virus is even more difficult. Any material suspected of containing the psittacosis virus must be regarded as potentially infectious and dangerous to handle, unless proper precautions are taken.

It is impossible to diagnose with certainty psittacosis in birds by clinical or gross anatomical examination. Impression smears made from lesions on serous membranes of the air sacs, liver, heart and intestines and properly stained by the method of Giemsa or Macchiavello may reveal the intracellular or extracellular elementary bodies. Material in which the parasites can be demonstrated microscopically is excellent for virus isolation by inoculation of mice. Attempts to propagate the virus directly from infected birds in the yolk sac of embryonated eggs are not always successful.

8.2.2 *Serological tests*

The complement-fixation test is valuable in the detection of psittacosis in man and some birds. In man, a rising titre in paired serum specimens taken 7-10 days apart can be considered presumptive evidence of active infection. The results of a single serum examination may be difficult to interpret unless a high titre is obtained. Recently, the use has been reported of a non-specific antigen for psittacosis diagnosis in man with a killed suspension of *Bacterium anitratum*. This antigen is being tested in several countries. *Lymphogranuloma venereum* antigen can be used for the complement-fixation test where a reliable specific antigen is not available.

¹ See: Meyer, K. F. & Eddie, B. (1956) Psittacosis. In: *Diagnostic procedures for virus and rickettsial diseases*, 2nd ed., New York, American Public Health Association.

The direct complement-fixation test detects antibodies in man, in psittacine birds and occasionally in pigeons. The indirect complement-fixation test should be used when the sera of turkeys, ducks, pheasants and pigeons are examined, as the direct test is not reliable in these birds. It should be noted, however, that the organism has frequently been isolated from birds and human beings who were negative to complement-fixation tests.

Although isolation of the virus will remain the final conclusive method in individual birds, particularly in relation to human infections, the complement-fixation tests provide evidence of active infection in aviaries or poultry flocks. Whenever reactions with titres above 1/16 are encountered, the psittacosis virus can be considered to be active in the flock, and further search will usually lead to its isolation.

8.3 Therapy and control

Therapy with broad-spectrum antibiotics is very effective in man. Treatment should be continued for 12-14 days to avoid relapses. Penicillin is of no value.

It has been established experimentally in the laboratory and in the field that psittacosis can be eliminated or controlled in parakeets through carefully supervised chemotherapy with tetracycline compounds given in medicated food (see Annex 13, page 81) or by injection. This procedure, however, cannot always be depended upon to eliminate the infection from birds, and carriers may remain. The highest standards of husbandry must also be maintained, including clean well-ventilated premises and the avoidance of overcrowding. No birds should be introduced into breeding flocks unless they originate in disease-free flocks and have been under observation for at least 30 days.

The control of disease in turkeys, ducks and squabs is difficult and no procedures can be set forth except that the premises be quarantined where the disease has been identified. Antibiotics have been used in pigeons with success, but in turkey flocks where acute disease outbreaks occur, this treatment has not proved practical because of its expense and uncertain value. Immunization procedures are now being investigated to determine their effectiveness in preventing disease in turkey breeding flocks. The problem in duck flocks has not been acute except in some instances. Antibiotics are of value in overcoming the acute phase of the disease in these birds, but virus carriers remain.

There is no recommendable control procedure for free-flying pigeons. Costly campaigns to reduce the pigeon population in urban communities are unwarranted as free-flying pigeons are seldom the cause of human infection. Control of infection among racing and fancy pigeons are individual problems. Antibiotics are reported to be of value.

8.4 International transfer of psittacine birds

Zoo officials and bird exhibitors usually follow the practice of holding imported psittacine birds in isolation for 30 days. Any birds showing suspicious signs are subjected to laboratory investigations (by direct and, if possible, indirect complement-fixation tests, and mouse inoculation of faecal samples). This procedure plus the use of medicated food is worth investigating as a possible alternative to complete prohibition of entry of these birds.

As stated above, experimental investigations are now in progress with medicated food administered to birds in commercial shipments between countries. Until, however, the value of this method has been definitely proved it is recommended that the importation of commercial shipments of psittacine birds be prohibited, but that consideration should be given to allowing individuals to import pets, rare birds, and stock of exceptional breeding value, after receiving special permission from the appropriate governmental authorities. Birds imported under these conditions should be shipped in individual cages unless they are very small, when two birds can be allowed in a cage.

9. Q FEVER

Q fever caused by the rickettsia *Coxiella (Rickettsia) burnetii* is recognized as an important public health problem. The results of a WHO-assisted survey of the distribution of Q fever in 32 countries¹ together with other published reports have shown infection in over 50 countries on five continents, and only in very few countries in which adequate investigations have been made have they failed to reveal the existence of this disease. In most countries domestic ruminants appear to be the most important reservoirs of Q fever, at least from the point of view of human infection.

Both animal and human infection occurs most commonly via the respiratory tract. Drinking contaminated milk can also infect, although experimentally it is not easy to obtain infection via the gastro-intestinal tract.

Because the organism is spread throughout the infected animal and is present in the blood, man may become infected from the meat, particularly at the time of slaughter. Many outbreaks in abattoirs have been recorded, and in some countries Q fever is legally recognized as an occupational disease of abattoir workers.

As well as transmission from animals to man, several incidents in which Q fever has been directly transmitted from man to man have been

¹ Kaplan, M. M. & Bertagna, P. (1955) *Bull. Wld Hlth Org.*, 13, 829

reported, including infections in the post-mortem room and among hospital aids.

In the infected ewe the organism becomes activated at the time of parturition and can be found throughout the body and in the excreta. Although abortion is rare, the placenta contains innumerable rickettsiae and these contaminate the ground. Rickettsiae are present in the milk, and the wool is also contaminated with organisms which may survive. Particularly in those countries where ewes are brought into yards to lamb, very high concentrations of rickettsiae may be found in the dust of these yards, and since the organism is very resistant to drying, such dust, when sheltered from direct sunlight, is highly infectious. Even in the presence of substantial antibody concentrations, ewes may again go through a cycle of infectivity at least at one further parturition.

The cycle in goats and cattle appears to be essentially similar to that in sheep.

In the original Australian investigations a wild-life cycle involving the tick *Haemaphysalis humerosa* and the bandicoot *Isodon torosus* was revealed and since then at least 22 species of tick, falling into six genera of Ixodid and two genera of Argasid ticks, have been shown to be naturally infected. Certain other wild mammals, particularly rodents, have been shown to be naturally infected at times. In the USSR it is thought that ticks are important in the transmission of the disease to man, but in most other countries the respiratory route of infection is regarded as the most important.

More recently infections of both wild and domestic birds have been shown to be common and the infection of migrating swallows (*Hirundo rustica*) and house-martins (*Delichon urbica*) suggests that those could be responsible for transporting the disease from one country to another. The evaluation of the importance of avian hosts in the natural history of Q fever requires further investigation.

9.1 The cycle of infection

In certain countries where the disease has been recognized for several years, a cycle of infection has been observed. During the late 1940's and early 1950's very large numbers of cases were reported; in the middle 1950's the numbers fell tenfold or more; and in 1958 a sudden increase has already been reported from three such countries. At the same time, from other countries evidence has been obtained of spread to further areas and to new domestic-animal hosts, probably as a result of movements of infected stock, and this suggests another problem in control.

9.2 Diagnosis

Isolation of *C. burnetii*, the inoculation of laboratory animals, and culture, should be undertaken only in well-equipped laboratories where

suitable precautions can be taken to protect laboratory personnel from infection.

The standard diagnostic procedure remains the complement-fixation test, but considerable advances have been made in the development of simpler agglutination tests. The micro-agglutination test^{1,2} is simple to perform, economical in antigen and appears to be highly specific in the hands of experienced workers, but requires some further study before it can be confidently recommended as a routine method to replace the complement-fixation test. The capillary test^{3,4} is a rapid and economical test of great value in survey work.

9.3 Control

Despite the advance in knowledge since 1950, the Committee still cannot recommend adequate control measures for this disease. Heat treatment of milk is a measure which can be easily applied, but pasteurization by the holding (vat) method at 143°F (61.7°C) for 30 minutes may not kill all the organisms. Raising the temperature by several degrees is effective. In laboratory workers and other individuals liable to heavy exposure to Q fever, it is recommended that vaccination procedures be carried out, although undesirable reactions have been reported in some instances. Mass vaccinations of human beings cannot be recommended at this time.

Vaccination of cattle has been tried on an experimental scale and some promising results were reported. This procedure, however, does not appear to be sufficiently effective to justify mass application.

The continued spread of the disease among domestic ruminants emphasizes the importance of giving consideration to the routine use of the complement-fixation test on sera from all ruminants passing to an apparently uninfected from an infected area, with the exclusion of all seropositives. It should be noted, however, that all infected animals are not detected by the complement-fixation test.

9.4 Treatment

Most cases of Q fever in man are mild and the patient will recover rapidly without specific therapy. More acute disease responds well to broad-spectrum antibiotics.

¹ World Health Organization (1953) *Advances in the control of zoonoses*, Geneva, p. 200 (*World Health Organization: Monograph Series*, No. 19)

² Babudieri, B. (1958) *Bull. Wld Hlth Org.*, 19, 981

³ Luoto, L. & Mason, D. M. (1955) *J. Immunol.*, 74, 222

⁴ Luoto, L. (1956) *J. Immunol.*, 77, 294

10. ARTHROPOD-BORNE VIRAL ENCEPHALITIDES

These viruses (sometimes referred to as "arbo" viruses) belong to the group including all the viruses known to be arthropod-borne and capable of infecting vertebrates. During the past few years, numerous isolations have been made in various parts of the world and the number of such viruses isolated exceeds 70; reports on many of these remain unpublished and with about 50 of them no disease syndrome has been associated.

The world distribution of infection¹ and classification of these viruses is under study by WHO and FAO in collaboration with other groups of workers. Most of these viruses appear to have only a limited range in geographical distribution, but evidence of infection with some member of this rapidly growing group is being obtained in almost all countries where investigations are being made. Extension of these investigations to further areas is desirable so that a global understanding of the problem may be obtained.

To illustrate the characteristics of this group, one important example from the mosquito-borne viruses and one from the tick-borne viruses will be described.

10.1 Mosquito-borne viruses

The viruses belonging to the equine viral encephalitides group (Eastern, Western, Venezuelan) and to the Japanese B group have all been shown to be capable of infecting birds, and it appears likely that the basic cycle by which they survive is a wild-bird—mosquito cycle, although many mammals can be infected and will show antibodies when a serological survey is made in an endemic or an epidemic area. These mammals, however, are not believed to play a significant role as a reservoir of the virus.

The most thoroughly studied of the equine encephalitides is Western equine encephalomyelitis (WEE), which has been recognized over a very large area of the USA and in western Canada.

WEE virus has been isolated from wild birds on several occasions, and serological evidence of natural infection has been found in a wide variety of wild and domestic birds. The virus has also been isolated from at least six species of mosquito in the field.

Climatic factors undoubtedly influence the incidence of WEE in horses and man. Epidemic years are usually those when there are long periods

¹ Yellow fever, because of its importance, has been dealt with separately by other expert groups (see *Wld Hlth Org. techn. Rep. Ser.*, 1950, 19; *Off. Rec. Wld Hlth Org.*, 1954, 56, 77; *Wld Hlth Org. techn. Rep. Ser.*, 1957, 136).

of warm weather and sufficient moisture which permits a rapid population increase of both birds and mosquitos. Horses and man become infected when there has been a large build-up of infected mosquitos in an area, the disease in horses often acting as a sentinel of human infection. In man there are hundreds of inapparent infections for every clinical case of encephalitis.

The survival of the WEE virus through the winter months when no infections occur has not been satisfactorily elucidated. The possibilities which have been suggested are over-wintering in hibernating mosquitos, return of the virus with migrating birds, and survival of the virus in latent form in vertebrate hosts.

10.2 Tick-borne viruses

In the tick-borne viral encephalitides, the viruses of the Russian spring-summer-louping-ill group have been studied most extensively. The viruses of this group, isolated in large areas of Europe and Asia, are all closely related antigenically and are subdivided by some workers only on their relative pathogenicity for different vertebrate hosts.

The disease in these areas is called tick-borne encephalitis. In the vector ticks trans-ovarian transmission of the virus has been demonstrated and there is, therefore, no difficulty in explaining survival of the virus. The disease is found in many tick-infested areas. Man and domestic animals become infected when they enter forest areas and are bitten by carrier ticks, and there may be a high incidence among workers in certain forests. Transmission to man also occurs through drinking the milk of infected goats. Extensive outbreaks of milk-borne disease have been reported in central and north-eastern European countries.

Man and his domestic animals are, however, not essential in the natural cycle of tick-borne encephalitis. Serological evidence of infection has been found in more than 100 species of birds and mammals. The disease in man not only produces an encephalitis similar to that caused by mosquito-borne viruses, but also a myelitic form which is difficult to distinguish clinically from poliomyelitis.

Members of the Russian spring-summer-louping-ill group of viruses have also been described as a cause of some forms of "haemorrhagic fever" (Omsk), and of Kyasanur forest disease (India).¹

10.3 Control

The present possibilities for control of tick-borne encephalitis are better than those for the mosquito-borne form.

¹ Smorodintsev, A. A. & Work, T. H. (1958) *Progress in medical virology*, Basel, S. Karger, vol. I, pp. 210, 248

(1) It is possible to take measures to reduce the number of ticks. In Czechoslovakia, it has been shown that the numbers of ticks are greatest in neglected pastures, and that careful management of pastures will lead to considerable reduction; while on sub-marginal land in Scotland it has been shown that removal of large, widely ranging mammals (sheep and cattle) from an area for a period of some years will lead to a great reduction in the number of ticks even when no attempt is made to control rodents.

(2) In the USSR it has been found that it is possible to obtain 97%-99% destruction of ticks in large areas of forest by dusting either from the ground or from the air with 30-50 kg per hectare of 10% DDT or BHC. When DDT is used this reduction is maintained for at least three years. Dusting with BHC is equally efficient during the first year, but does not have so good a long-term effect. The use of insecticides is concentrated in the neighbourhood of roads, paths and other areas where numbers of humans are at risk.

(3) Exposed workers can be encouraged to wear protective clothing impregnated with insect repellents or insecticides, and can be trained to remove promptly any attached ticks.

(4) Formalinized vaccines have been developed, and in the USSR are found to give good protection to those persons, such as timber workers, who have to go into heavily tick-infested endemic areas. The mouse-brain vaccine used has, however, caused severe reactions in some instances, and further research is in progress, in particular on the development of a vaccine grown in tissue culture.

(5) The virus in milk can be destroyed by heating, but the temperature must reach 65°-70°C (149°-158°F) for 20 minutes. Normal pasteurization procedures will not be effective.

Insufficient is known of the natural history of mosquito-borne viruses to make satisfactory control practicable. Where the most important vector has a specialized habit, and epidemics only occur under very clearly defined conditions, vector control in the main towns may prove effective at least in reducing the incidence of the disease. It has also been suggested that the presence of trees which act as bird roosts and nesting sites close to houses may increase the risk of infection for the inhabitants. In the present state of knowledge, reduction in the number of vectors presents the best hope of obtaining some control.

Vaccines which have been tested so far against mosquito-borne encephalitides have been liable to cause severe reactions and have not given very satisfactory results in man. They are to be recommended for specially exposed laboratory personnel. In horses, for Eastern and Western equine encephalomyelitis, excellent results in preventing losses are obtained when formalinized chick embryo vaccines are given annually.

11. HYDATIDOSIS

Hydatidosis is a world-wide public health and economic problem, recognized in varying degrees in every continent. The areas with the greatest known incidence are southern South America, parts of Oceania, and the Mediterranean littoral. It is also of considerable importance in the Eastern Mediterranean countries and in South Africa. Several other areas are affected, but to a somewhat lesser extent. In all those areas the disease is caused by the cystic stage of the very small tapeworm *Echinococcus granulosus*, the common definitive host of which is the domestic dog.¹

11.1 Epidemiology

The infected dog eliminates large numbers of the tapeworm eggs which, when ingested by man, sheep, cattle, swine, goats, horses, camels or other herbivorous animals, pass through the wall of the intestine, and lodge in various organs of these intermediate hosts, where they form cysts. These cysts, each containing numerous scolices (heads of immature tapeworms), may be found in any part of the body, but are most commonly encountered in the liver and the lungs. The life cycle of the parasite is completed when cystic organs of animals are eaten by dogs, and new tapeworms develop in the intestinal tract of these animals. This chain of infection, in domestic animals, is the most common and represents the major source of the public health hazard and economic losses resulting from hydatidosis. It should be noted, however, that wild animals may be involved in part, or in all, of the life cycle just described. Wolves, jackals, dingoes or other wild carnivores may harbour the adult tapeworm, thus substituting for the domestic dog as the definitive host. Similarly, elk, moose, reindeer, kangaroos, deer and other wild herbivores may serve as intermediate hosts.

The disease is most often transmitted to man directly from the dog, but indirect transmission from dog to man via foodstuffs and water is a real danger. In some areas, authorities consider that contaminated drinking water supplies are the major source of infection.

¹ It is now generally recognized that a second species of tapeworm is the cause of hydatidosis in the islands and neighbouring continental areas of the northern Pacific and in parts of Eurasia. Although similar in many respects to the tapeworm described above, this species (*E. multilocularis*) is peculiar in that its life cycle involves foxes (the red fox *Vulpes vulpes*, and the arctic fox *Alopex lagopus*) as definitive hosts, from which it is transmitted to form the cystic stage in wild rodents. It has been shown that the domestic dog may serve as host for the adult worm, but it would appear that the larger domestic animals are not susceptible to infection. Man, however, is quite susceptible, and human hydatidosis is not uncommon in the areas concerned.

When dogs eat infective offal, the parasites mature in the intestine for a period of about six weeks before eggs are shed. It has been reported that the life of the tapeworm after maturity is limited to some six months and, therefore, it is thought that unless they are re-infected, dogs will become clear of *E. granulosus* in about eight months. These findings are clearly important, and it is very desirable that investigations to establish their general validity be undertaken.

Much investigation is needed on the biology of the parasite. Such basic information should help to clarify the epidemiology of this disease, and might well lead to better control procedures.

11.2 Control

The sickness and death of human beings, and the heavy economic losses, which result from hydatidosis make it highly desirable that responsible authorities take appropriate measures to reduce and eventually eliminate the problem.

The major efforts in the campaign against hydatidosis must be directed towards reducing the disease in its animal reservoir. Since the dog, infected with *E. granulosus*, is the common transmitting host of hydatid disease, control measures should be designed to minimize and eventually eradicate such canine infections. Only in this way can ultimate control of the parasite be gained and the danger to man be eliminated.

Iceland once had what was probably the world's highest incidence of hydatidosis, yet the disease has now been eradicated from that country. This situation is the result of a campaign which comprised public education, provision and enforced use of slaughterhouses with veterinary inspection of all meat, laws limiting the number of dogs, and the anthelmintic treatment of all dogs.

An antihydatidosis programme may be conveniently considered under the following headings: eradication of canine infection (anthelmintic treatment; stray-dog elimination; reduction of wild canidae population); prophylactic measures against canine reinfection; and educational measures. These various aspects of hydatidosis control should be pursued concomitantly. It is obviously useless to treat dogs for echinococcal infection if the same dogs may gain access to cystic offal and promptly become reinfected.

11.2.1 Eradication of canine infection

11.2.1.1 Anthelmintic treatment

Arecoline hydrobromide has been widely used for many years and, although possessing disadvantages, it remains the drug of choice. The recommended dose is 4 mg per kg of body weight. Various methods

have been used to administer this compound, but the recommended technique is the use of a 1% aqueous solution to which a small amount of sugar has been added. A useful procedure for the mass treatment of dogs is given in Annex 14 (see page 82). The treatment should be repeated at regular intervals, preferably every four months.¹

There is urgent need for research activities to develop an anthelmintic that does not cause vomiting, that is more effective for eliminating the tapeworm, and that is taeniocidal.

11.2.1.2 *Stray-dog elimination*

The elimination of ownerless dogs is essential in antihydatidosis campaigns as well as in the fight against such diseases as rabies. The effectiveness of the plan to eliminate stray animals is dependent, firstly upon community education resulting in acceptance of the necessity of their removal; secondly, upon laws and regulations to provide the necessary support; thirdly, upon the diligence of the enforcement agency. Proper facilities for apprehending and impounding the stray dogs are, of course, basic requirements. Instruction of dog-wardens as to the value of their work is important.

11.2.1.3 *Reduction of wild canidae population*

In areas where wild animals of the canine family such as wolves, jackals, dingoes and foxes are known to harbour the adult parasite, measures for reducing the populations of these animals should be adopted.

11.2.2 *Prophylactic measures against canine reinfection*

Improved practices of slaughtering livestock, with appropriate methods of offal disposal, are the keystone of hydatidosis eradication; this is also the most difficult phase of the programme, from the standpoint of attaining extensive improvement. Special emphasis must be laid on the centralization of slaughtering services and the provision of adequate veterinary meat-inspection at each of the centralized plants. This, however, will not solve the problem created by the existence of various small abattoirs and of farm slaughtering for home consumption. Success in this aspect of hydatidosis eradication must, therefore, depend largely upon the development in rural butchers and individual farmers of a greater sense of responsibility through an understanding of the dangers involved. This becomes

¹ A purgative action is necessary for success of the treatment. Re-infestation can occur within one month of treatment in heavily exposed dogs and the parasite can mature and shed eggs after about seven weeks. Thus more frequent treatment of dogs (every two months) may be necessary according to particular local conditions (see, for example, Gemmell, M. A. (1958) *Aust. vet. J.*, **34**, 207).

a matter of rural education concerning public health and animal hygiene.

In no circumstances should dogs be allowed on the premises of abattoirs. This ban should include the use of dogs for rounding up or driving livestock on such premises.

Some research has been done on a vaccine for immunization of the dog against this parasite, but there are insufficient results to date to permit its value to be assessed.

11.2.3 *Educational measures*

Although the goal of the antihydatidosis programme must be the elimination of the disease from its animal reservoir, such a result cannot possibly be attained immediately. In the meantime, while people live in the vicinity of this reservoir, they must be made aware of the danger and of how to avoid it. An important part of the programme must, therefore, be an intensified campaign of public health education. This activity should not stop with the hanging of a few posters, but, rather, should make use of the many modern techniques of imparting information to the public, and particularly to children of school age on means of transmission of infection.

11.3 **Diagnosis of human hydatidosis**

It is seldom possible to diagnose a case of hydatidosis in man by clinical signs or symptoms alone. X-ray is an important aid to diagnosis, and is essential for the localization of pulmonary or cerebral cysts. The allergy tests, such as Casoni's and modifications thereof, are widely used for differential diagnosis, but the variable results obtained show that there is a need for further evaluation to develop a satisfactory standardized antigen and technique. Recent research on serological tests indicates that the complement-fixation test with an improved antigen,¹ and an indirect haemagglutination test,² deserve wider trial.

12. **ANIMAL INFLUENZA AND ITS POSSIBLE RELATIONSHIP TO HUMAN INFLUENZA**

The Committee welcomed the opportunity of considering this subject in a joint meeting with the WHO Expert Committee on Respiratory Virus Diseases. The report of the latter deals extensively with the influenza

¹ Bensted, H. J. & Atkinson, J. D. (1958) *Brit. med. J.*, **2**, 203

² Garabedian, G. A., Matossian, R. M. & Djanian, A. Y. (1957) *J. Immunol.*, **78**, 269

problem in general¹ and the following section considers only briefly one component of the question.

A clinical swine influenza infection has been known to exist in the swine population of the USA since the severe human pandemic of 1918. A virus was isolated as the causative agent in 1931 and was of the type A (common soluble antigen) of influenza viruses. Some influenza authorities believe that the infection in swine originated from human sources, but the possible role of swine or of other animals as inter-epidemic reservoirs of the human influenza virus has been the subject of much speculation. Consequently, when the human pandemic of 1957, caused by a distinctly new variant of type A (A2 = A/Asian), began in the Far East early in the spring of 1957, WHO took the opportunity of organizing an animal serum survey in some 25 countries throughout the world. The immediate purpose of the survey was to determine if the A2 strain, or a closely related one, existed in the animal population before the pandemic struck a particular country; and, if not, whether the strain would establish itself in domestic animals known to be susceptible under natural conditions to other strains of type A virus. Furthermore, it was hoped to gain some preliminary information on the status of other type A strains known to exist in horses and swine in some countries.

The results of this preliminary survey were still incomplete when the Committee met, but it was agreed that the information already gained certainly warranted continuation and expansion of analogous surveys, and specific research to elucidate the possible role of animals in human influenza. It is now known, for example, that distinct disease entities caused by type A influenza strains occur in epizootic form in horses (caused by A-equine/Prague/56 virus) in central and northern Europe, with serological evidence of its presence in the USA where a type A infection in swine is well known. The virus of classical fowl pest (fowl plague) and two strains of viruses isolated from ducks all belong to type A.² The significance of these findings cannot be evaluated at the present time and the problem requires careful investigation. The Committee strongly recommends that both WHO and FAO continue to encourage and co-ordinate research in this field.

13. OTHER ZOO NOSES

The Committee considered it would be useful to give short summaries of recent developments covering some important zoonoses which could

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1959, 170

² The Sendai virus (haemagglutinating virus of Japan) has been isolated from pigs, hamsters and mice in Japan, and from mice in China, and has been reported to cause human disease in the USSR. This virus was formerly included with influenza strains as type D, but is now considered to be separate from the influenza group.

not be treated fully at the meeting because of lack of time. Trichinosis,^{1, 2} jungle yellow fever,^{3, 4} and taeniasis^{1, 2} (beef and pork origin) have been considered in other WHO/FAO publications.

13.1 Toxoplasmosis

Toxoplasmosis is producing increasing concern as a cause of severe infection in man and animals. Congenital human infections are often followed by tragic consequences because the central nervous system may be involved. The disease in adults frequently affects the eyes, although it has a protean symptomatology.

The causative organism, *Toxoplasma gondii*, is one of the most widespread infectious agents in the animal kingdom, including all the domestic animals, but the means of its transmission is not known. Considerable circumstantial evidence exists that in many instances, but not in all, animals serve as a reservoir for human infection. The epidemiology of this disease urgently requires clarification in order that suitable preventive measures may be developed.

One of the great difficulties with respect to this disease is its diagnosis. The Sabin-Feldmann dye test and the complement-fixation test are the two most widely used procedures and in experienced hands they give fairly satisfactory results, although each of them has limitations. Unfortunately, most diagnostic laboratories are not equipped to perform the valuable dye test. This test requires the use of living toxoplasma organisms, and numerous laboratory infections have occurred. A human serum containing "accessory factor" is also needed, and is difficult to obtain and to standardize. Diagnostic procedures where living antigens are used should be concentrated in specialized laboratories in each country.

The standardization of diagnostic tests, possibly on the basis of an international standard serum, is highly desirable so that more uniform and comparable results would be obtainable. A recently developed haemagglutination test shows some promise. The Committee recommends that WHO and FAO encourage wherever possible the development of such tests, stimulate studies to clarify the epidemiology of the disease, and support the training of laboratory personnel for this work.

13.2 Listeriosis

The lack of exact knowledge about the epidemiology and means of transmission of listeriosis resembles very much the situation with respect

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1955, **99**

² World Health Organization (1957) *Meat hygiene*, Geneva (*World Health Organization: Monograph Series*, No. 33)

³ *Wld Hlth Org. techn. Rep. Ser.*, 1950, **19**

⁴ *Off. Rec. Wld Hlth Org.*, 1954, **56**, 77

to toxoplasmosis. The causative organism of listeriosis, *Listeria monocytogenes*, is found widely in animals, where it causes encephalitides in cattle, sheep and goats. Human disease is characterized by a meningo-encephalitis; infection of the new-born occurs. In recent years the disease in humans has been recognized and reported with much greater frequency than previously, and listeriosis in humans must now be considered as a not uncommon infection.¹ Diagnosis of the disease by means of serological tests and culture of the organism does not present great difficulties, but infection may be overlooked unless physicians and veterinarians are on the alert for it.

13.3 Cutaneous and visceral larva migrans

Cutaneous larva migrans or creeping eruption is a common infection of man in warm climates where the dog and cat hookworms (*Ancylostoma braziliense* and perhaps *A. caninum*) are widespread. Man becomes infected by the entry of the dog and cat hookworm larva into the skin, where they migrate about, causing a dermatitis of varying intensity. In some instances the invasion may be so great as to cause hospitalization of the victim. The larvae are eventually destroyed in the skin. Diagnosis is made by clinical examination. Infection is usually found among those who are exposed to animal faeces, especially children on beaches, lawns or playgrounds where larvae are present. Control is effected by restriction of dogs and cats, and destruction of their faecal material. Household pets should be frequently examined for parasitic infection. Soil disinfectants (e.g., borax) have been found to be of value in selected areas such as schools and playgrounds.

Visceral larva migrans is due to the ingestion of dog and cat roundworm eggs (*Toxocara canis* and *cati*) by individuals, usually children. The eggs hatch out and the larvae enter the circulation. They fail to complete their life cycle, but wander about causing varying reactions. In some instances tissue injury may be so great as to cause a generalized reaction, and some human infections terminate fatally. Diagnosis is usually by histopathological examination of biopsied tissue. Serological tests are being used experimentally. Control is the same as for creeping eruption. Public health education is of considerable value, especially among children.

Other animal parasites may also cause cutaneous or visceral larva migrans. This problem warrants further investigation in various countries.

¹ Seeliger, H. P. R. (1958) *Listeriose*, Leipzig, J. A. Barth, 2nd ed., p. 78 et seq.

13.4 Dermatomycoses

Human and animal ringworm is a clinical entity involving the skin and its appendages and caused by the same, or closely related, dermatophytes. The individual dermatophytes manifest varying degrees of host specificity. Some are primarily parasites of man, others of animals, and still others are free-living agents commonly found in soil.

Most of the dermatomycoses in man are caused by human-type organisms. However, a large percentage of the ringworm occurring on the exposed parts of the body of the human hosts is caused by animal-type dermatophytes, with animals serving as reservoirs and vectors of infection. In urban areas, *Microsporum canis*, the common cause of dog and cat ringworm, is the principal cause of animal ringworm in man. In rural areas, *Trichophyton verrucosum* and *T. mentagrophytes* are the main animal ringworm infections affecting man.

Although ringworm in man and animals is of world-wide occurrence, there are few data available on its morbidity. Surveys to determine its extent should be encouraged.

The control of zoophilic dermatophyte infections in human and animal populations rests upon the detection and elimination of reservoirs of infection. Thus, cases in man and animals must be traced to their sources, and such sources must be placed under proper veterinary care. Where small animals are involved their destruction may be necessary. Examination with a Wood's light apparatus, and routine performance by veterinarians of microscopic examination of suspect skin lesions are practical and effective methods of detecting infected animals. Culture techniques are necessary to determine precisely the fungus species involved. In addition, vigorous attention must be directed towards known reservoirs of infection which include cats in breeding establishments, stray cats and dogs, and infected cattle and rodents. A successful demonstration control programme has been operating for several years in Leeds, England, where zoophilic dermatophyte infections presented an important public health problem.¹

Therapy of ringworm in man and animals requires much additional research; present-day methods of treatment are not satisfactory. The feasibility of utilizing chemical or biological prophylaxis also warrants study. The Committee strongly recommends further survey and research in all fields of human and animal dermatomycoses and systemic mycoses. Epidemiological studies are also needed, particularly in rural areas, and should be a combined effort between medical practitioners and veterinarians. The teaching of these subjects in veterinary or medical schools should not be neglected. Diagnostic laboratories should recognize the need for specialized training in this field.

¹ La Touche, C. J. (1955) *Vet. Rec.*, **67**, 666

13.5 Trematode infections

13.5.1 *Fasciolosis*

Recently, infections with *Fasciola hepatica*, the common liver-fluke of domestic animals, have been reported in a considerable number of human beings in several countries. Cases of *F. gigantica* infection in man have also been reported. It is possible that undetected human infection exists with these liver-flukes in other areas where drinking-water and food are liable to be contaminated with cercariae, or among fishermen, farmers, and others who work in snail-infested fields, streams, ponds and lakes.

13.5.2 *Bilharziasis*

Human and animal infection with *Schistosoma japonicum* has been found to be widespread in the Pacific region and in the countries of eastern and south-eastern Asia, where it is one of the most important parasitic diseases. Considerable information on the bionomics of the intermediate hosts and animal reservoirs has been gathered in recent years, but more ecological studies on snails and on wild and domestic animal reservoirs are needed to determine more clearly the role of animal reservoirs in human disease.

Recently, foci of human bilharziasis have been discovered in areas where animal infection is common but human infection was believed to be non-existent. This finding calls for search for human infection in other areas where a similar situation exists.

In many countries where schistosomes capable of attaining sexual maturity in man are absent, the cercariae of blood flukes of birds and rodents capable of penetrating human skin are present. They die almost immediately after penetration but they give rise to an irritating, often severe, dermatitis called "swimmers' itch" (*Schistosoma dermatitis*).

13.6 Tularaemia

Tularaemia is a common disease of various wild animals in the northern hemisphere; it occasionally affects domestic animals, especially sheep in which it may cause epizootics. The disease is transmitted to man principally by the handling of rabbit carcasses, contact with infected animals, bites by ticks, inhalation of infected dust, and the contamination of water by diseased rodents. Rarely, infections may result from bites of animals who are passive carriers of the organism. Food-borne infections result from eating undercooked rabbits. Occupational disease occurs among wool shearers and commercial rabbit butchers.

Control is based on avoidance of exposure, on the use of protective gloves when handling suspect material, and on adequate cooking or

heating of meat or water that may be contaminated. Rodent and animal control is recommended in endemic areas. Rat-proofing of rural homes and store-houses is important. Recently, a living attenuated vaccine has been developed in the USSR and used in especially exposed population groups with beneficial results.

Streptomycin, the tetrocyclines and chloramphenicol have been found to be effective therapeutically.

13.7 Cat-scratch disease

Cat-scratch disease has been reported from many countries in recent years. The name stems from the fact that most, though not all, of the cases are associated with a cat scratch. The etiological agent is unknown. Cats or other animals involved show no signs of disease and it is not known if they are passive or mechanical carriers of the disease agent. No one has been able to produce the disease in cats, dogs or laboratory animals. The disease in man is characterized by a regional adenitis, general malaise and usually fever. These signs usually occur from 2 to 8 days after exposure, although in some instances later. A diagnostic skin test involving material aspirated from an involved regional lymph node has been used, but the antigen is not readily available.

14. ECOLOGY OF WILD ANIMAL RESERVOIRS

Several of the important zoonoses have wild animal reservoirs. With few exceptions, information on the ecology of wild hosts available from most areas of the world is inadequate. This has often led to hesitation or failure in the application of control measures. It is, therefore, necessary that enzootic foci of zoonoses should be carefully investigated where this has not been done so far. Besides a study of environmental factors, the investigation of such foci should include taxonomic survey of all vertebrates and their parasites and detailed studies on animal populations, life histories, migration, food and habits of the reservoir hosts. Where a vector is involved, it should be studied similarly. The tissues and excretions of the hosts and vectors should be surveyed for the causal organism, antibodies and morbid changes.

This work warrants the co-operation of epidemiologists, ecologists, microbiologists and parasitologists with advice from botanists, geologists and climatologists. In practice, a very elaborate organization is not generally necessary; a few enthusiastic and interested field workers backed by an efficient laboratory and museum service can accomplish much.

Information on the biology and ecology of reservoir hosts and vectors should be compiled, preferably on a regional basis, and made available

to workers in the area. Production of field guide-books, containing instructions on the collection, preservation and preliminary identification of animals should be encouraged, particularly in areas for which such guides do not exist.

Sometimes animals new to an area are introduced for the biological control of vermin without due regard to the effect they may have on human health. For example, the introduction of the Javan mongoose (*Herpestes javanicus*) into the Caribbean islands and of ferrets into Cuba for the control of rats was followed by the establishment of new reservoirs of rabies. Careful ecological studies, with due consideration of the possible effects on zoonoses, must be undertaken before animals new to an area are thus introduced. Also, the use of vermin killers containing living pathogenic organisms (e.g., rat baits containing *Salmonella*) should be prohibited.

The Committee noted with interest the method of detection of wild enzootic foci of certain zoonoses from ecological peculiarities of topography, soil, vegetation and other environmental factors, which has been applied over the years in many countries.¹ This method appears to be useful in detecting foci of leishmaniasis, arthropod-borne diseases and trematode infections, and may find application in other areas.

15. ANIMAL "ORPHAN" VIRUSES

In the animal field an analogous situation is being encountered to that in humans with respect to the ECHO (entero-cytopathogenic human "orphan") viruses. The problem has aptly been summarized by the phrase "viruses in search of a disease". Thus, large numbers of strains of viruses have been uncovered, principally by tissue-culture techniques, from man and animals, but their importance as disease-producing agents is far from clear. In some instances they are known to cause frank disease, but frequently they are not associated with any disease process. Some strains of human and animal viruses thus isolated appear to be related, and the systematic grouping and study of these agents is highly desirable. The value of doing this can be illustrated by the finding that the HA1 virus (haemadsorption virus type 1), known to cause a respiratory disease in man, is now suspected of being involved in the etiology of the shipping-fever complex in cattle.

The Committee realizes that study and grouping of the "orphan" viruses present very considerable practical difficulties, but such work is essential lest the great confusion already existing becomes completely

¹ This has been exemplified in recent years by the mass application of "landscape epidemiology" by Pavlovsky and his co-workers in the USSR.

chaotic. The Committee recommends that WHO and FAO take whatever steps possible to co-ordinate this work between groups already engaged on the problem.

16. EMERGING ZONOSSES

New disease entities or previously unsuspected human-animal disease relationships are being reported with increasing frequency. It is clear that host-parasite-environment interactions are constantly changing, and this, together with the availability of more refined tools for biological study, no doubt partially explains these observations. It can be anticipated further that, with such factors operating as (a) the increasing control or eradication of major known diseases, (b) the great changes in human and animal ecological patterns which are being brought about by development of virgin territories, and (c) the increase in human and animal populations, diseases will come to the fore which have been submerged, latent or restricted to well-defined areas and animal or human groups. Recent observations, such as (a) the apparent spread or mere uncovering of arthropod-borne viral infections in new areas, (b) the detection in animal sera of substances reacting serologically but of which the specificity is doubtful with respect to the poliomyelitis, coxsackie, measles and mumps viruses, and (c) the problem of animal influenza and animal "orphan" viruses (see pages 47 and 54), illustrate some aspects of this situation. It is important, therefore, to clarify wherever possible the natural history of specific disease agents and to be alert to the possible emergence of new zoonoses.

The Committee notes with satisfaction that WHO, with FAO collaboration, is considering specific studies in this direction and that a special meeting on the subject will be convened. For example, one of the failures in studies on communicable diseases up to now has been our inability to follow the progression of disease in geographical areas at different points of time. This failure cannot be attributed to human oversight, but rather to the limited opportunities and tools available for instituting appropriate studies. While conditions are better in this connexion, it will be some years before there will be sufficient facilities to cope with the many problems associated with studies of progress in communicable diseases. Nevertheless, in the meantime certain steps are possible that would no doubt be of invaluable assistance later when more detailed studies become feasible. Thus, serum specimens from different age-groups in human beings and animals in various parts of the world could be taken within a given span of time, and the specimens catalogued and stored in a freeze-dried state for examination. Thereby, where a particular study is undertaken, perhaps many years later, serum specimens from the human

and animal population of a geographical area of interest would be available for examination by qualified laboratories.

Such work can be undertaken and co-ordinated uniquely by such organizations as WHO and FAO, and should be of immense benefit in improving our knowledge of communicable diseases both in the near and more distant future. The Committee, therefore, strongly recommends that WHO and FAO give the maximum possible support to such activities.

Annex 1

A LIST OF ZOO NOSES

Some Diseases naturally transmitted between Vertebrate Animals and Man

The following list of zoonoses is not comprehensive, although all the known major ones have been included. The diseases listed have been confined to those in which the animal link in the chain of infection to man is considered to be of importance, although not always essential.

Many proved zoonoses, particularly helminth infections of relatively rare occurrence,¹ have been omitted, as well as those diseases caused by fish and reptile toxins. Also omitted are those diseases of which the causative organism, while found in both man and animals, appears to be derived from a common source, for example, soil, or where the importance of the vertebrate animal component in the disease cycle appears to be negligible. Examples of these diseases include diphtheria, gas gangrene, tetanus, botulism, shigellosis, amoebiasis, actinomycosis, aspergillosis, coccidioidomycosis, histoplasmosis, moniliasis, nocardiosis, sarcosporidiosis and many others (see also pages 54-56 of the report).

1. VIRUS DISEASES

<i>Disease</i>	<i>Causative organism</i>	<i>Animals principally involved</i>
Arthropod-borne virus infections:		
Colorado tick fever	Colorado tick fever virus	Rodents
Eastern equine encephalitis	Eastern equine virus	Birds, equines
Encephalomyocarditis	Encephalomyocarditis virus	Rodents
Japanese B encephalitis	Japanese B virus	Birds, horses, swine and other mammals
Murray Valley encephalitis	Murray Valley virus	Birds
Rift Valley fever	Rift Valley virus	Sheep, cattle
St. Louis encephalitis	St. Louis virus	Birds

¹ Wright, W. H. (1947) *Ann. N.Y. Acad. Sci.*, **48**, 553

<i>Disease</i>	<i>Causative organism</i>	<i>Animals principally involved</i>
Tick-borne spring-summer group (including louping-ill, Russian spring-summer encephalitis, Omsk haemorrhagic fever, Kyasanur forest disease)	Russian spring-summer-louping-ill group of viruses	Goats, sheep, birds, wild mammals
Venezuelan equine encephalitis	Venezuelan equine virus	Equines, rodents
Wesselsbron fever	Wesselsbron virus	Sheep
Western equine encephalitis	Western equine virus	Birds, equines
West Nile fever	West Nile fever virus	Birds
Yellow fever (jungle)	Yellow fever virus	Monkeys
Aujeszky's disease (pseudo-rabies)	Aujeszky's virus	Ruminants, swine, dogs
B virus disease	B virus	Monkeys
Cat-scratch disease	Cat-scratch disease virus (?)	Cats
Cowpox (milker's nodule ?)	Cowpox or vaccinia virus	Cattle
Equine infectious anaemia	Equine infectious anaemia virus	Equines
Foot-and-mouth disease	Foot-and-mouth disease virus	Ruminants, swine
Influenza	Influenza virus type A	Swine, horses
Lymphocytic choriomeningitis	Lymphocytic choriomeningitis virus	Mice, dogs, monkeys
Newcastle disease	Newcastle disease virus	Chickens
Ovine pustular dermatitis (contagious ecthyma)	Ovine pustular dermatitis virus	Sheep, goats
Psittacosis (ornithosis)	Psittacosis virus	Psittacines, poultry, pigeons
Rabies	Rabies virus	Dogs, cats, wolves, foxes, jackals, bats, other wild animals
Sendai virus disease	Sendai virus	Swine, rodents
Vesicular stomatitis	Vesicular stomatitis virus	Equines, cattle, swine

2. RICKETTSIAL DISEASES

Murine (endemic) typhus	<i>Rickettsia typhi</i> (mooseri)	Rats
North Queensland tick typhus	<i>Rickettsia australis</i>	Bandicoots, rodents
Q fever	<i>Coxiella burnetii</i>	Cattle, sheep, goats, wild and domestic birds and mammals
Rickettsialpox	<i>Rickettsia akari</i>	Mice
Scrub typhus (Tsutsugamushi)	<i>Rickettsia tsutsugamushi</i>	Rodents
Spotted fever (including Rocky Mountain, Brazilian and Colombian spotted fevers)	<i>Rickettsia rickettsii</i>	Dogs, rodents and other animals

<i>Disease</i>	<i>Causative organism</i>	<i>Animals principally involved</i>
Boutonneuse fever Kenya typhus Also probably Indian tick typhus and South African tick-bite fever	<i>Rickettsia conorii</i>	Dogs, rodents

3. BACTERIAL DISEASES

Anthrax	<i>Bacillus anthracis</i>	Ruminants, equines, swine
Brucellosis	<i>Brucella abortus</i> , <i>Br. suis</i> , <i>Br. melitensis</i>	Cattle, swine, goats, sheep, hares
Bacterial food poisoning and intoxications	<i>Salmonella</i> spp., staphylococcal enterotoxin, <i>Clostridium welchii</i> , and others	Ruminants, swine, poultry, rodents
Colibacillosis	<i>Escherichia</i> spp., Arizona group of Enterobacteriaceae	Poultry, swine, dogs
Erysipeloid	<i>Erysipelothrix rhusiopathiae</i>	Swine, poultry, fish
Glanders	<i>Actinobacillus mallei</i>	Equines
Leptospirosis	<i>Leptospira</i> spp.	Rodents, dogs, swine, cattle
Listeriosis	<i>Listeria monocytogenes</i>	Rodents, sheep, cattle, swine
Melioidosis	<i>Pseudomonas pseudomallei</i>	Rodents, sheep, goats, equines, swine
Pasteurellosis	<i>Pasteurella multocida</i>	Mammals, birds
Plague	<i>Pasteurella pestis</i>	Rodents
Pseudotuberculosis	<i>Pasteurella pseudotuberculosis</i>	Rodents, cats, fowls
Rat-bite fever	<i>Spirillum minus</i> , <i>Streptobacillus moniliformis</i>	Rodents
Relapsing fever (endemic)	<i>Borrelia</i> spp.	Rodents
Salmonellosis	<i>Salmonella</i> spp.	Mammals, birds, poultry
Staphylococcosis	<i>Staphylococcus</i> spp.	Mammals
Streptococcosis	<i>Streptococcus</i> spp.	Mammals
Tuberculosis	<i>Mycobacterium tuberculosis</i> var. <i>bovis</i> var. <i>hominis</i> var. <i>avium</i>	Cattle, goats, swine, cats Dogs, swine, monkeys Poultry, swine, cattle

<i>Disease</i>	<i>Causative organism</i>	<i>Animals principally involved</i>
Tularemia	<i>Pasteurella tularensis</i>	Rabbits, hares, sheep, wild rodents
Vibriosis	<i>Vibrio foetus</i>	Cattle, sheep

4. FUNGUS DISEASES

Ringworm, favus	<i>Microsporum</i> spp. <i>Trichophyton</i> spp.	Dogs, cats, horses Horses, cattle, poultry, small mammals
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5. PROTOZOAL DISEASES

Balantidiasis	<i>Balantidium coli</i>	Swine
Leishmaniasis :		
Espundia (American leishmaniasis)	<i>Leishmania braziliensis</i>	Dogs, cats, rodents
Kala-azar	<i>Leishmania donovani</i>	Dogs, cats, rodents
Oriental sore	<i>Leishmania tropica</i>	Dogs, cats, rodents
Toxoplasmosis	<i>Toxoplasma gondii</i>	Mammals, birds
Trypanosomiasis :		
African sleeping sickness	<i>Trypanosoma gambiense</i> (?)	Wild and domestic ruminants
	<i>Trypanosoma rhodesiense</i>	Wild game
Chagas' disease	<i>Trypanosoma cruzi</i>	Cats, dogs, rodents

6. HELMINTH DISEASES

Trematode diseases

Amphistomiasis (gastrodiscoidiasis)	<i>Gastrodiscoides hominis</i>	Swine
Bilharziasis	<i>Schistosoma japonicum</i> (and occasionally other species)	Ruminants, swine, dogs, cats
Clonorchiasis	<i>Clonorchis sinensis</i>	Dogs, cats, swine, wild mammals, fish
Dicrocoeliasis	<i>Dicrocoelium dendriticum</i>	Ruminants, equines
Echinostomiasis	<i>Echinostoma ilocanum</i> (and occasionally other species)	Cats, dogs, rodents
Fascioliasis	<i>Fasciola hepatica</i> , <i>Fasciola gigantica</i>	Ruminants
Fasciolopsiasis	<i>Fasciolopsis buski</i>	Swine, dogs
Heterophyiasis	<i>Heterophyes heterophyes</i>	Cats, dogs, fish
Metagonimiasis	<i>Metagonimus yokogawai</i>	Cats, dogs, fish
Opisthorchiasis	<i>Opisthorchis felineus</i> (and occasionally other species)	Cats, dogs, wildlife, fish

<i>Disease</i>	<i>Causative organism</i>	<i>Animals principally involved</i>
Paragonimiasis	<i>Paragonimus westermani</i>	Cats, dogs, wildlife
"Swimmer's itch"	<i>Schistosoma</i> spp.	Birds, rodents

Cestode diseases

Diphyllobothriasis	<i>Diphyllobothrium latum</i>	Fish, carnivores
Dipylidiasis	<i>Dipylidium caninum</i>	Dogs, cats
Hydatidosis	<i>Echinococcus granulosus</i> (larval cyst stage) and occasionally <i>E. multilocularis</i>	Dogs, ruminants, swine Foxes, rodents
Hymenolepiasis	<i>Hymenolepis nana</i>	Rats, mice
Sparganosis	<i>Sparganum mansonoides</i> (and other species)	Cats, mice and other mammals
Taeniasis and cysticercosis	<i>Taenia saginata</i> <i>Taenia solium</i> and its larval form <i>Cysticercus cellulosae</i>	Cattle Swine

Nematode diseases

Ancylostomiasis and cutaneous larva migrans ("creeping eruption")	<i>Ancylostoma braziliense</i> (and occasionally other species)	Dogs, cats
Strongyloidiasis	<i>Strongyloides stercoralis</i>	Dogs
Toxocariasis (visceral larva migrans)	<i>Toxocara canis</i> <i>Toxocara cati</i>	Dogs Cats
Trichinosis	<i>Trichinella spiralis</i>	Swine, rodents, wild carnivores
Trichostrongyliasis	<i>Trichostrongylus colubri- formis</i> (and occasion- ally other species)	Ruminants

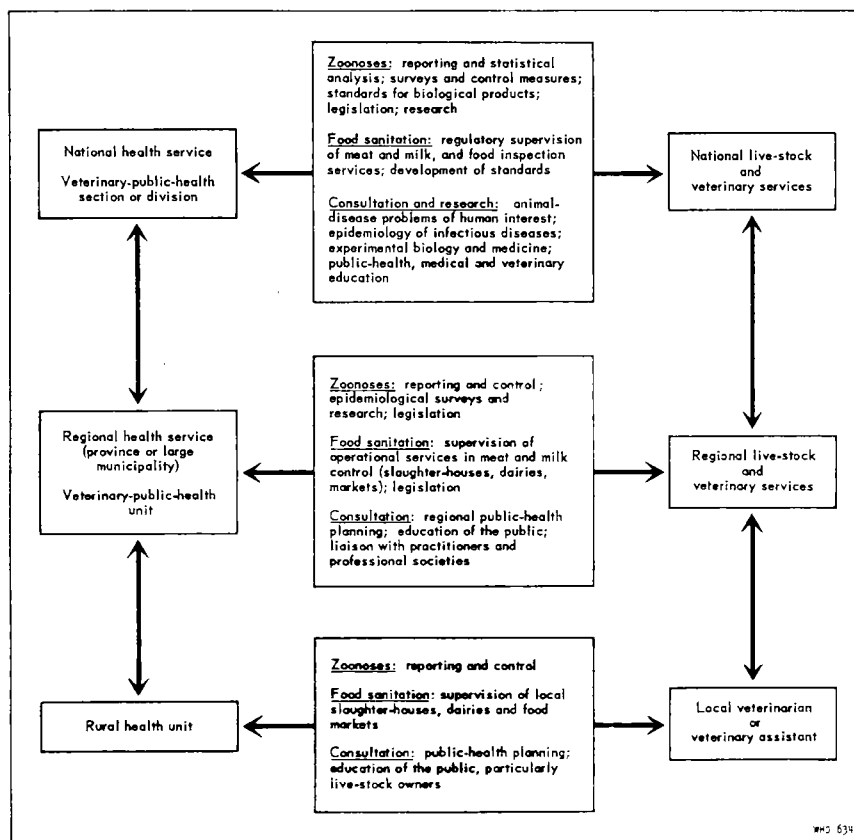
7. ARTHROPOD AND INSECT INFESTATION

Acariasis	<i>Dermanyssus</i> spp., <i>Sarcoptes</i> spp., <i>Trombicula</i> spp., etc.	Poultry, domestic animals, wildlife
Bug-bites	<i>Cimex</i> spp., <i>Triatoma</i> spp., etc.	Chickens, birds, small mammals
Flea-bites	<i>Xenopsylla</i> , <i>Ctenocephalus</i> , <i>Ceratophyllus</i> , <i>Tunga</i> , etc.	Rats, dogs, cats, swine, birds

<i>Disease</i>	<i>Causative organism</i>	<i>Animals principally involved</i>
Myiasis	<i>Oestrus</i> , <i>Hypoderma</i> , <i>Gasterophilus</i> , <i>Cochliomyia</i> , etc.	Ruminants, equines
Tick-bites	<i>Ixodes</i> , <i>Dermacentor</i> , <i>Rhipicephalus</i> , <i>Haemaphysalis</i> , <i>Amblyomma</i> , <i>Argas</i> , etc.	Dogs, cattle

Annex 2

VETERINARY PUBLIC-HEALTH ACTIVITY AT VARIOUS LEVELS OF GOVERNMENT



Annex 3

REPORTING OF ZOO NOSES

With respect to means for improving zoonoses reporting, the following excerpts from the report of an Advisory Group on Veterinary Public Health¹ are pertinent :

" Morbidity and mortality reporting

" Systems of animal-disease reporting are weak in many countries. The first principle in effectively combating diseases is to establish effective methods for ascertaining their incidence and progress.

" Organized reporting of animal morbidity and mortality from zoonoses is essential to the development of veterinary public-health operations, and steps should be taken in this direction. Frequently, the establishment of effective zoonosis-reporting systems by health departments encourages analogous efforts with respect to purely animal disease by veterinary departments, and a combination of the two often results in greatly benefiting health and veterinary activities.

" The organization of a reporting programme requires co-operation among all interested agencies and groups (agriculture, health, veterinarians and statisticians). In most instances the programme with respect to zoonoses has been inaugurated at the provincial (State) level of health administration, eventually growing into a national system. The development of the programme logically falls under the guidance of the public-health veterinarian, working in close co-operation with interested groups.

" The first step in organizing an animal-disease reporting programme is to secure the assistance of statistical experts to advise and guide in the technical aspects of collecting and analysing data. In most situations the best method is to use a code number for each disease on which information is requested, so that it may be readily transferred to cards that can be tabulated and sorted by machine. Such procedures are very efficient and permit reports to be compiled and distributed within a few days of receipt of the field data. Cards for reporting can be provided by the national health service to the provincial authorities, although occasionally a provincial government may purchase cards for reporting. These cards are usually mailed twice a month. The list of diseases on which information is requested is agreed on by the various groups collaborating.

" Co-operation of veterinary practitioners is essential to the success of a reporting system. This co-operation can usually be achieved by keeping practitioners informed regularly of the incidence of various diseases in their area. The value of these notices is increased if they include brief summaries of diseases of current interest."

" Where there is a lack of veterinarians, it is often possible to utilize the services of an assistant trained in specific veterinary techniques (stock inspector, vaccinator) to serve for reporting suspected outbreaks of zoonoses to the health or agricultural services (where exchange of information should be arranged). Often, no personnel of any kind with veterinary training is available, but the village chief, religious leader, or other person trusted by the rural community as regards their livestock needs can be used. Short-term training can be given to these individuals to enable them to recognize the rudimentary signs of epizootic diseases so that they may be immediately reported to the responsible veterinary and/or health authorities."

¹ *Wld Hlth Org. techn. Rep. Ser.*, 1956, 111, 15, 16

The following zoonoses are divided into those of world-wide prevalence (List 1, for use in almost all countries), and those which are of more local importance (List 2).

List 1 — World-wide

(Identification of type strains involved in some of the zoonoses listed below is not a common practice, but efforts in this direction should be fostered as much as possible.)

Anthrax

Brucellosis : identified by type where possible

Cat-scratch disease

Dermatophytoses : identified by type where possible

Encephalitides, arthropod-borne (e.g., Eastern, Western, Venezuelan, Murray Valley, St. Louis, Japanese B, Russian spring-summer) : identified by type where possible

Erysipeloid

Food poisoning : by type (e.g., *Salmonella*, *Cl. welchii*, staphylococcal enterotoxin, others)

Hydatidosis

Leptospirosis : identified by type where possible

Listeriosis

Liver fluke disease (fascioliasis)

Lymphocytic choriomeningitis

Newcastle disease

Pasteurellosis

Plague

Psittacosis (ornithosis)

Q fever

Rabies

Rickettsialpox

Salmonellosis : identified by type where possible

Septic sore throat (streptococcosis)

Taeniasis (beef and pork tapeworm and cysticercosis)

Toxoplasmosis

Trichinosis

Tuberculosis, bovine

Tularaemia

Vibriosis

Visceral larva migrans (toxocariasis)

List 2 — Local

These are notifiable where locally prevalent, but worthy of inclusion for reference purposes in all lists (for more complete lists of zoonoses see Annex 1, page 56).

American spotted fever (Rocky Mountain, Brazilian, Colombian)
Bilharziasis
Clonorchiasis
Cowpox
Cutaneous larva migrans ("creeping eruption")
Diphyllbothriasis
Glanders
Hymenolepiasis
Influenza, swine
Leishmaniasis
Meliodosis
Murine typhus
Opisthorchiasis
Ovine pustular dermatitis (contagious ecthyma)
Paragonimiasis
Rat-bite fever
Relapsing fever (endemic)
Rift Valley fever
Scrub typhus (Tsutsugamushi)
Sparganosis
Tick-bite fever (ricketsial, e.g., South African, boutonneuse, Indian, Kenya)
Trypanosomiasis (Chagas' disease, African sleeping sickness)
Yellow fever, jungle

Annex 4**SALMONELLOSIS : PASTEURIZATION OF RAW EGG PRODUCTS**

The small difference between the temperature which ensures death of the salmonellae and that which results in coagulation of the product presents certain technical difficulties when the heat treatment is to be undertaken commercially. However, carefully controlled experiments recently carried out on a commercial scale at the Government Research Institute of Dairy Industry, Hillerød, Denmark, have shown that it is possible to pasteurize raw egg products with a reasonable degree of safety in a pasteurizer used for pasteurization of milk. This can be done when the construction is modified so as to ensure an adequate flow through the apparatus of the circulating water at a temperature that is only 0.5°C (0.9°F) higher than the temperature at which the products are being pasteurized. The cooling section of the pasteurizer must also be especially adapted.

The following recommendations are given in a report to be published by the Institute :

Whole egg should be pasteurized at 65°-69°C (149°-156.2°F) for 90-180 seconds

Egg yolk should be pasteurized at 64°-66°C (147.2°-150.8°F) for 180 seconds

Fermented egg white : ammonia is added to reach a pH of 10.3, after which the material is held for 20 hours at 15°C (59°F) ; pasteurization is then carried out at 51°-52°C (123.8°-125.6°F) for 90-180 seconds

Fresh egg white can be pasteurized at 55°-56°C (131°-132.8°F) for 30 minutes, after the addition of 0.5%-1.0% sodium citrate or 10%-20% sucrose, if the whipping ability of the final product is of minor importance.

Annex 5

THE FUNCTIONS OF INTERNATIONAL AND NATIONAL
SALMONELLA CENTRES

The present International Salmonella and Escherichia Centre, directed by Dr F. Kauffmann, originated in 1938 at the Statens Seruminstitut, Copenhagen, as the "International Salmonella Centre" with support from the Commonwealth Foundation of New York. In 1947 the Expert Committee on Biological Standardization recommended that the Centre should be supported by WHO, and this recommendation was adopted by the First World Health Assembly in 1948. In 1950 the International Association of Microbiological Societies proposed that the Centre's activity should be extended to include work on escherichiae. This proposal was accepted by the WHO Executive Board in 1952, and the "International Salmonella Centre" accordingly became the "International Salmonella and Escherichia Centre".

The International Centre undertakes to :

- (a) collect, identify and type salmonella and escherichia strains ;
- (b) supply free of charge to national salmonella centres salmonella and escherichia strains and diagnostic sera ;
- (c) carry out further research work in salmonella and the escherichia.

In order to promote world-wide identification of the salmonellae it is necessary for the International Centre to have close contact with the laboratories in the different countries, and this has been achieved by the creation of national centres designated by the government of the country concerned. The relationship of the International Centre with the national centres is that of technical and scientific collaboration. The International Centre supplies to each newly established national centre a set of diagnostic sera and test strains in order that it may do all its own routine typing (see Table 1, page 68). The International Centre also gives advice on the organization of the laboratory work. In addition, bacteriologists from national centres can receive WHO fellowships to enable them to be trained at the International Centre. All the national centres are entitled to send salmonella strains to the International Centre for further identification, particularly in the case of an outbreak, or if the organism is of a rare or anomalous type.

At the present time there are some 51 national centres. In principle there is in each country only one officially recognized National Salmonella Centre. This does not mean that only one laboratory concerns itself with

salmonella work, especially if the country is large or has a highly developed public health service. Also there are, in many countries, research or similar institutions, such as departments of universities, in which enteric bacteriology is intensively studied. The national centre, however, is the official direct link between the International Centre and the country's other laboratories. It is intended to act as a screen but not as a barrier. Thus, there should be no interference with free scientific intercourse between the International Centre and any other laboratory, provided that this does not hinder orderly development of the subject or of national laboratory facilities in the country.

The functions of a national centre vis-à-vis other laboratories in a country are similar to those of the International Centre vis-à-vis the national centres. Primarily, a national centre serves as a reference laboratory for all the laboratories of the country. It has, therefore, to investigate the antigenic structure and biochemical reactions of any culture which gives equivocal results or which it is thought could be a salmonella strain needing identification. This activity brings the national centre into contact with all types of laboratory (public health, university, hospital, private, veterinary and food control).

The national centre is responsible for distributing the diagnostic material needed by other laboratories within its own territory. This material can be prepared at the national centre with the standard sera and strains supplied by the International Centre. For small countries, or where staff is not sufficiently experienced, some material may have to be purchased from large centres or special firms in other countries.

The national centre should also facilitate the identification of salmonellae by giving help and advice in technical matters and by training personnel from peripheral laboratories. In small or less developed countries, the national centre may have to undertake a great deal of routine work.

In addition, the national centres may be called upon to play a direct role in other aspects of the fight against diseases caused by the salmonellae by taking part in bacteriological surveys, by collaborating closely with the veterinary service and official laboratories for the control of foodstuffs, and by advising in the treatment of patients and carriers. The extent of this contribution will vary from one country to another, depending upon the structure and the stage of development of the public health service.

TABLE 1. SALMONELLA MATERIALS SUPPLIED BY THE INTERNATIONAL SALMONELLA AND ESCHERICHIA CENTRE TO NEWLY-ESTABLISHED NATIONAL SALMONELLA CENTRES

Diagnostic sera for slide agglutination (not absorbed)		
No.	Sera *	Prepared with
	O Sera	
100	I, II, XII	<i>S. paratyphi</i> A
101	IV, V, XII, XXVII	<i>S. paratyphi</i> B + <i>S. essen</i> 173 + <i>S. schleissheim</i>
102	VI, VII, VIII	<i>S. thompson</i> + <i>S. newport</i>
103	IX, XII	<i>S. typhi</i> + <i>S. enteritidis</i>
104	III, X, XV	<i>S. london</i> + <i>S. newington</i>
105	polyvalent	I, II, III, IV, V, VI, VII, VIII, IX, X, XII, XV, XXVII
	Vi Serum	
106	VI, XXIX, z ₁₄	Ballerup living
	H Sera	
107	a	<i>S. paratyphi</i> A
108	b	<i>S. minnesota</i> phase 1
109	c	<i>S. choleraesuis</i> phase 1
110	d	<i>S. typhi</i>
111	e, n, x	<i>S. abortus equi</i>
112	g, p	<i>S. dublin</i>
113	i	<i>S. bonariensis</i> phase 1
114	1, 2, 3, 5	<i>S. newport</i> phase 2 + <i>S. thompson</i> phase 2

* The O and Vi sera should be used in dilution 1 : 5 or 1 : 10, the H sera in dilution 1 : 50 or 1 : 100 (with 0.25% phenol-salt solution and kept in the refrigerator at 4°-5° C (39.2°-41° F)).

TABLE 1 (continued)

Test strains				
No.	Strain	O Antigen	H Antigen	
			Phase 1	Phase 2
1	<i>S. paratyphi</i> A 1015	I, II, XII	a	—
3	<i>S. paratyphi</i> B 8006	IV, V, XII	b	1, 2
5	<i>S. paratyphi</i> B var. <i>java</i>	IV, V, XII	b	—
248	<i>S. paratyphi</i> B (O form)	IV, V, XII	—	—
31	<i>S. schleissheim</i> 13	IV, XII, XXVII	b	—
22	<i>S. essen</i> 173	IV, XII	g, m	—
209	<i>S. typhimurium</i> 1074	IV, V, XII	i	—
270	<i>S. abortus equi</i> W H 2	IV, XII	—	e, n, x
211	<i>S. choleraesuis</i> 179	VI, VII	c	—
201	<i>S. lomita</i> 91c	(VII)	e, h	1, 5
40	<i>S. thompson</i> var. <i>berlin</i> 2988	VI, VII	—	1, 5
175	<i>S. virginia</i>	(VIII)	d	—
51	<i>S. newport</i> var. <i>puerto rico</i>	VI, VIII	—	1, 2, 3
145	<i>S. bonariensis</i> C 12	VI, VIII	i	e, n, x
57	<i>S. typhi</i> H 901	IX, XII	d	—
58	<i>S. typhi</i> O 901	IX, XII	—	—
60	<i>S. typhi</i> Watson	IX, XII, VI	d	—
62	<i>S. typhi</i> Vi 1	(IX, XII), Vi	(d)	—
269	<i>S. enteritidis</i> 5168	IX, XII	g, m	—
65	<i>S. dublin</i> 215	I, IX, XII	g, p	—
74	<i>S. gallinarum gallina</i>	IX, XII	—	—
76	<i>S. london</i> 1446	III, X	i, v	1, 6
84	<i>S. newington</i> C 2	III, XV	e, h	1, 6
218	<i>S. minnesota</i> P	XXI	b	—
107	Ballerup 7851	XXIX, Vi	Z ₁₄	—

Annex 6

PATHOGENIC LEPTOSPIRA SEROTYPES AND SUB-SEROTYPES

Serogroup	Serotype *	Sub-serotype *	Type strain
Icterohaemorrhagiae	** Icterohaemorrhagiae (AB) ** Icterohaemorrhagiae (A) † naam † mankarso † sarmin † birkini † birkini † ndambari	Icterohaemorrhagiae incompleta birkini smithii	M 20 RGA Naam Mankarso Sarmin Birkin Smith Ndambari
Javanica	** javanica † pol cokus		Veldrat Batavia 46 Pol Cox
canicola	** canicola † schueffneri † benjamin jonsis sumneri malaya		Hond Utrecht IV Vleermuis 90 C Benjamin Jones Sumner H-6
ballum	** ballum ** ballum (AB)	ballumensis castellonis	Mus 127 Castellón 3
pyrogenes	** pyrogenes † zannoni = australis [B] abramis biggis † hamptoni		Salinem Zannoni Abraham Biggs Hampton
cynopteri	† cynopteri butembo		3522 C Butembo
sentot	sentot		Sentot
autumnalis	** autumnalis (AB) ** autumnalis (A) † bangkinang mooris	autumnalis rachmati	Akiyami A Rachmat Bangkinang I Moores
djasiman	† djasiman		Djasiman

* For designation of terms of serotypes and sub-serotypes, see footnote, page 24.

** International Reference Anti-Leptospira Serum and homologous culture (type strain) available to national laboratories on request from WHO/FAO Leptospirosis Reference Laboratories listed in Annex 7 (see page 72)

† International Reference Anti-Leptospira Serum in preparation

†† Provisional classification pending further work

Serogroup	Serotype *	Sub-serotype *	Type strain
australis	** australis = australis [A] muenchen †† esposito		Ballico München C-90 Esposito
pomona	** pomona		Pomona
grippotyphosa	** grippotyphosa		Moskva V
hebdomadis	** hebdomadis † medanensis † wolffii † hardjo ** mini mini †, †† kremastos †† kabura †† Jules haemolytica †† haemolytica worsfoldi ** sejroe ** saxkoebling †† borincana	mini szwajizak haemolytica ricardi	Hebdomadis Hond HC 3705 Hardjoprajitno Sari Szwajizak Kremastos Kabura Jules Marsh Richardson Worsfold M 84 Mus 24 HS-622
bataviae	** bataviae † paidjan		Swart Paidjan
semaranga	** semaranga		Veldrat S 173
andamana	** andamana		CH 11
hyos	** § hyos = mitis Johnson †† hyos	hyos bakeri	Mitis Johnson LT 79
celledoni	† celledoni celledoni [II]	celledoni whitcomb	Celledoni Whitcomb

* For designation of terms of serotypes and sub-serotypes, see footnote, page 24.

** International Reference Anti-Leptospira Serum and homologous culture (type strain) available to national laboratories on request from WHO/FAO Leptospirosis Reference Laboratories listed in Annex 7 (see page 72)

† International Reference Anti-Leptospira Serum in preparation

†† Provisional classification pending further work

§ Possibly the type strain is *L. perepelitsin*, a human strain isolated in 1938 in the USSR which later was recognized to be serologically identical with the strain Mitis Johnson (Varfolomeeva, A. A. (1958) *J. Hyg. Epidem. Microbiol. Immunol.*, 2, 50)

Annex 7**WHO/FAO LEPTOSPIROSIS REFERENCE LABORATORIES****AUSTRALIA**

Laboratory of the Queensland Department of Health and Home Affairs
Brisbane
Queensland
(Dr A. Fryberg)

ITALY

Istituto Superiore di Sanità
Viale Regina Elena 299
Rome

JAPAN

Department of Viral and Rickettsial Diseases
National Institute of Health
Tokyo
(Dr M. Kitaoka)

NETHERLANDS

Institute for Tropical Hygiene and Geographical Pathology (Royal Tropical Institute)
Mauritskade 57 A
Amsterdam
(Dr J. W. Wolff)

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

The Wellcome Laboratories of Tropical Medicine
The Wellcome Building, Euston Road
London N.W.1
(Dr J. C. Broom)

UNITED STATES OF AMERICA

Division of Veterinary Medicine
Walter Reed Army Institute of Research
Walter Reed Army Medical Center
Washington 12, D.C.

Annex 8**CONTROL OF TUBERCULOSIS IN CATTLE ***

It is emphasized at the outset that, in order to assure the success of any control programme in tuberculosis, it is essential that the official scheme of eradication should have the support of veterinarians and other members of the agricultural community. The backing of the medical profession will greatly assist in obtaining public support.

Tuberculin-testing is the basic method of obtaining information on the incidence and distribution of tuberculosis, and an adequate meat-inspection service is a valuable aid. It is important that efforts are made to prevent non-infected premises from becoming infected, and relatively free areas from being more heavily infected. In an area where there is only little infection, it may be easy to build up a completely free area. This provides a psychological stimulus to the control programme and also provides a supply of healthy animals to replace reacting cattle as eradication proceeds in more heavily infected areas. It is important that such a reliable source of animals should be available and that disease-free markets should be provided. It may be considered desirable to mark permanently animals that react to tuberculin, particularly after some progress has been made in the control of the disease.

According to the conditions in a country, a programme can be made voluntary or compulsory, or these methods can be combined. Voluntary steps alone usually result in only limited control. An educational programme will do much to arouse interest in the control of tuberculosis, but it is necessary to give some form of financial assistance, because the eradication of tuberculosis involves considerable effort and some expense on the part of the farmer. A bonus for milk from tuberculosis-free herds, and later a reduction of price for milk from diseased herds, have been found very effective. In beef-raising areas, a per head bonus for disease-free herds, and perhaps bonuses or reductions for disease-free or infected carcasses, respectively, can also be effective.

Methods of control

In countries where the dairy industry has not been well developed, bovine tuberculosis may not be a serious problem. However, as soon as intensive dairy methods begin to be developed, and particularly when

* Abstracted and slightly modified from *Wld Hlth Org. techn. Rep. Ser.*, 1951, 40, 5

European breeds of cattle are introduced, it is important that attempts should be made to control the disease.

Test and slaughter

In the USA, cattle which reacted to tuberculin were slaughtered from the inception of the federal control programme in 1917. This was possible because of the economic resources of that country, but it should be made clear that, although the over-all incidence was only about 5%, the incidence in some of the Eastern states was from 20% to 50% in the adult stock.

It is obvious that the test and slaughter method is a highly effective procedure for eradicating bovine tuberculosis.

Modified eradication procedures

In the early stages of an eradication scheme, slaughtering of reactors is usually economically impossible, and in the Scandinavian countries and the United Kingdom very good progress has been made without this drastic procedure.

The following steps are advised :

(a) Farmers in various parts of the country are encouraged to develop tuberculosis-free herds on a voluntary basis. Bonuses are offered as indicated previously.

(b) The reacting animals are sold and go into other herds. There may be some objections to this procedure, but it should be realized that the reacting animals are often from the best herds in the country, that the great majority are only slightly affected, and that they go into other herds already containing tuberculous animals. The important consideration in this method is that there are more and more animals no longer exposed to the risk of infection.

(c) In individual herds the incidence of tuberculosis in young stock is usually low. It is generally agreed that if the incidence of reactors to tuberculin at the first test in the adult stock is high, it is not advisable to attempt to build up a tuberculosis-free herd from the non-reacting adult animals. In deciding on such a course, the prevalence of tuberculin reactors in all the different age-groups has to be taken into consideration. It may even be decided that the reactors need not all be disposed of at once, if suitable isolation facilities are available. If reacting animals are retained, a careful clinical examination must be made periodically (including microscopic examinations of excretions) to detect "open" lesions, particularly cases of pulmonary, uterine, and mammary tuberculosis.¹

¹ The terms "open" and "closed" are not definitive as applied to bovine tuberculosis. Cows not uncommonly shed tubercle bacilli in their milk even though no lesions can be detected in their mammary glands.

(d) In the early stages of eradication, herds are retested every two to three months, then at longer intervals (except when new infections are detected) and, as areas become free, possibly every two or three years or even less frequently.

(e) Free herds should be protected from new infection by all available means. Where skim milk or whey is used for feeding calves, these products should originate from tuberculosis-free herds, or the product should be sufficiently heated or pasteurized. Cattle not recognized as tuberculosis-free should not be allowed to be taken to the same pastures, markets, etc., as healthy cattle. When most herds in a certain area or village are clean, the introduction of other than tuberculosis-free animals into that part of the country should be prohibited.

(f) The time when compulsory eradication is undertaken in a particular area depends upon the prevalence of tuberculosis, and economic conditions. It is difficult to give precise figures. If the prevalence of tuberculosis in infected herds is very high, compulsory eradication should not be undertaken until, say, from 70% to 90% of the herds have been made free (as was done in Denmark). On the other hand, if there is only a low prevalence of infection within herds, compulsory eradication can be begun when, say, from 10% to 50% of herds are free from infection. During all stages of eradication, clinical and "open" cases that are detected, particularly animals with tuberculosis of the lungs, uterus, or udder, should be killed.

Tuberculin and tuberculin-testing

Tuberculin

The activity of all tuberculins depends on the presence of specific tuberculo-proteins produced by the tubercle bacillus during its growth.

In Koch's Old Tuberculin this tuberculo-protein is mixed with the proteins of the medium and cannot be purified. When, however, the tubercle bacillus is grown in a synthetic medium (containing no protein) all the tuberculo-protein present can be precipitated by trichloroacetic acid or by other methods. This precipitate is known as "purified protein derivative" or PPD tuberculin.

It was hoped that PPD would prove to be a homogeneous product that could be standardized by such simple chemical methods as determination of nitrogen, but it is now known that biological activity does not always correspond to the nitrogen content. PPD as used consists of a mixture of protein molecules of different size and slightly differing biological properties. PPD tuberculin is, however, the purest and most uniform product used in tuberculin-testing, and the dried product is stable over very long periods.

The existence of a standard tuberculin now enables countries to compare results and ensure that any new tuberculin is of sufficient potency to detect tuberculosis in cattle (see page 27, footnote ²).

The production of tuberculin, and the performance of the test, must be supervised by the State to ensure uniformity of procedure, but this does not mean that the tuberculin need be produced in a State laboratory.

The tuberculin test

It may appear from the account given below that tuberculin-testing is complicated, but it should be emphasized that the complications arise chiefly when the incidence of tuberculosis in a herd has become low. Tuberculosis has always been greatly reduced in incidence, or eradicated, whenever any tuberculin-test has been systematically applied and reacting animals segregated.

The original subcutaneous tuberculin test has been abandoned as a primary test and replaced by the intradermal test carried out on the skin of the neck or in the caudal fold and read 72 hours later.

If the tubercle bacillus were the only agent producing sensitivity to tuberculin, tuberculin-testing would be simple because the use of a sufficiently potent tuberculin would ensure the detection of all, or all but a very small number of, tuberculous animals. Unfortunately, the following infections, and some other unknown agents, cause non-specific sensitization to mammalian tuberculin: *Mycobacterium tuberculosis avium*; *Myc. johnei*; "skin lesions" or so-called "skin tuberculosis";¹ and *Myc. tuberculosis hominis*. The latter is, of course, not a "non-specific sensitization", but it confuses the interpretation of the test because it is difficult to distinguish the allergy caused by the unimportant (in cattle) human infection from infection caused by the important bovine-type organism.

No tuberculin has so far been produced that will detect all tuberculous animals without causing non-specific reactions in a varying, but high, proportion of those tested. Unfortunately, some animals that do not react are suffering from advanced open tuberculosis. All recent work on tuberculin and tuberculin-testing has been directed to increasing the specificity of the test. The main advance has been the introduction of the comparative intradermal test in which avian and mammalian tuberculins are injected intradermally in two sites of the neck at the same time. The importance and probably the type of non-specific infection varies in different countries or parts of countries, and it is unlikely that any standard test will be universally adopted.

It should be emphasized that the tuberculin-test is a herd test, and it should not be interpreted in a mechanical manner. All facts concerning

¹ These terms are used to denote skin nodules containing as yet unidentified acid-fast bacteria which cause non-specific reactions to tuberculin.

the herd should be examined, particularly the incidence of tuberculosis in the herd and its previous history ; also, its possible exposure to infection, including infections causing non-specific sensitization.

As eradication proceeds, the proportion of reacting animals with no visible lesions will increase. This does not mean that the actual number of such animals will increase.

The status of the tuberculin-tests was summarized by Bang¹ in 1892. Despite changes in method his statement describes the position today :

“ It is found that the tuberculin-test is no more perfect than are other things in this world. Sometimes it fails. Animals with a very real degree of tuberculosis will sometimes fail to react, and the same applies to animals with a very slight degree of the disease. Further, a positive reaction has been observed several times in animals in which no tuberculous changes were found on examination of the organs when the animals were slaughtered ... but it would be the greatest folly to reject this method because it is not able to give everything we desire.”

Annex 9

ANTHRAX : ASCOLI PRECIPITATION TEST

This test is very useful, particularly with respect to the examination of hides suspected of originating from animals infected with anthrax. The successful use of this test depends, however, upon the employment of potent precipitating serum and careful technique on the part of the laboratory worker. Precipitating serum is best prepared in donkeys. Strains of micro-organisms vary widely in their ability to act as antigens in the hyper-immunization of donkeys. Strains of *Bacillus cereus* (*anthracoides*) have been found to serve as the best antigens. It is often necessary to try several strains before a good antigenic strain is found. In this connexion, the Istituto Sieroterapico Milanese Serafino Belfanti, Milan, which first prepared the precipitating serum, and the Institut Pasteur, Paris, can provide further information. Briefly, thick suspensions in saline are made of agar-slant growths of the different strains of micro-organisms being tested. The suspensions are boiled for a few minutes, cooled and filtered, and the clear filtrate is stratified with precipitating serum of known potency.

¹ Bang, B. (1892) *Ugeskrift for Landmænd*, 6 (translation in *Selected works*, 1936, London, Levin & Munksgaard, p. 268)

Annex 10**ANTHRAX : OUTLINE OF WOOL-STERILIZATION PROCESS
USED IN THE UNITED KINGDOM**

The process for the sterilization of hair and wool imported from dangerous sources is conducted at a central sterilization plant in Liverpool.

The hair or wool is washed for 10 minutes in 0.27% sodium carbonate solution at 40°C (104°F). This is followed by another washing in a synthetic soap solution (2 lb of a detergent added to 3000 Imp. gal. of water) (approximately 200 g per 3000 litres) for 10 minutes at 40°C (104°F). The third step is a 10-minute exposure to 2.0% formaldehyde at 40°C (104°F). This is followed by a second formaldehyde wash of 2% for 10 minutes at the same temperature. The fifth step is a rinse in cold water for 3 minutes. In between each of these stages the wool or hair is rolled out so as to remove as much of the previous solution as possible. After the last step, the material is dried in an oven at 120°C (248°F) for 7 minutes, the temperature dropping rapidly so that the wool and hair is not scorched. After the material is dried, it is blown into baling presses.

The two formaldehyde bowls are enclosed by a glass superstructure through which there is ready access to the scouring equipment. There is an exhaust system within the superstructure which removes the formaldehyde fumes with the aid of fans. This system has reduced the irritating effects of the formaldehyde to a minimum.

Annex 11**ANTHRAX : PROCEDURES RECOMMENDED IN PLANTS
WHERE POTENTIALLY CONTAMINATED MATERIALS
ARE HANDLED ***

(1) All dusty operations in leather, hair and wool industries which handle potentially contaminated material should have adequate exhaust facilities, and should be isolated from other operations.

(2) Floors, walls, stairways, elevators, and transport vehicles, etc., should be of such construction that they may be readily cleaned by wet sweeping or suction. Cleaning should be performed daily.

* Adapted from Wolff, A. H. & Heimann, H. (1951) *Amer. J. Hyg.*, 53, 80

- (3) All dust, dirt, and sweepings should be burned.
 - (4) In the scouring procedure the circulation of clean water during the draining-off of the sludge is advisable.
 - (5) Blending of wool should be done after scouring, when this is compatible with the manufacturing process.
 - (6) Drying of the wool should be conducted at the maximum temperature compatible with the process.
 - (7) Dyeing of the raw stock wool should be carried out as frequently as possible.
 - (8) Finished products, and dyed wool and yarn, should be handled and stored in such a manner that there is no danger of contamination from dust, dirt, grease, and excrement from raw materials.
 - (9) Protective clothing should be worn by employees in all occupations where exposure to anthrax is likely. The clothing should consist of loose-fitting overalls with long sleeves and collars, and hats. Boots and aprons impervious to water should be available for workers in wet processes. The wearing of gloves should be mandatory in all instances in which it would be compatible with the process. The wearing of respirators may be necessary in certain dusty operations.
 - (10) Adequate lavatory and locker space should be made available. Two lockers, preferably in separate rooms, one for street clothes and the other for work clothes, should be provided for each worker exposed to the materials considered to be contaminated with *B. anthracis*. These workers should be required to take showers and to change completely from work clothing to street clothing, including shoes, before leaving the factory. Additionally, adequate lunch-room facilities should be available so that employees need not eat their food in the same room where contaminated materials are being processed.
 - (11) Employees should be thoroughly instructed as to the cause, nature, and control of anthrax. All cuts, scratches, abrasions, and pimples should be reported immediately, and adequate medical attention should be given to such lesions.
 - (12) Effluents from such factories must not be discharged into places where animals are left.
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Annex 12

ANTHRAX : IMPORTATION OF ANIMAL BY-PRODUCTS *

Hides, skins, and hair

Importation is allowed for hides and skins which have been dried, dry-salted, or wet-salted; wet-salting must be done for a minimum of 14 days. Pickled pelts are allowed entry provided they have been treated with a depilatory paste and are subsequently washed and placed in a lime bath for 48 hours.

The importation of cow hair, goat hair, and pigs' bristle from slaughtered animals is allowed, provided the hair has been pulled from hides or skins which have been treated by the lime or other chemical process. (In the lime process, the skins are soaked in milk of lime, sometimes with the addition of arsenicals, in vats for periods of up to one week. In the chemical process, depilatory paste (sulfides and arsenicals) is painted on the flesh sides of skins, after which the hair can be readily removed, washed, and dried by special machinery.)

Other hair (cow-tail hair, hogs' hair, etc.) must be subjected to boiling for one hour, dyed, or fermented and washed in a disinfecting solution equal in strength to 5% phenol solution, or be subjected to other approved methods of disinfection.

Steamed bone-flour, bone-meal, meat-meal, horn-meal, bones, hoofs, and hoof-meal

Every importation must be accompanied by a certificate of a duly authorized officer of the government of the country of origin stating:

(1) the factory of origin, which must be one which has been approved by the Ministry;

(2) that the material referred to in the certificate has been subjected to one of the following methods of sterilization (stating which method was adopted), namely:

(a) subjection to a dry heat of 140°C (284°F) for not less than three hours; or

(b) subjection to a moist heat under steam pressure of not less than twenty pounds per square inch (1.4 kg per cm²; 1.3 atmospheres) for fifteen minutes; or

* Requirements of the Ministry of Agriculture, Fisheries and Food for England and Wales

- (c) treatment of the bones, after they are broken, with the vapour of benzine boiling between 95°C and 115°C (203°-239°F) for not less than four hours, live steam to be thereafter admitted for one hour;
- (3) that after treatment every precaution was taken to prevent the reinfection of the sterilized product;
- (4) that the sterilized product was packed at the factory in new bags; and
- (5) that before the sterilized product was loaded into any vehicle, vessel, or barge for conveyance to the port of shipment to the United Kingdom, the said vehicle, vessel, or barge was disinfected with disinfectant solution equal in disinfective efficiency to a 5% solution of standard phenol.

NOTE. The Minister is prepared to grant licences in respect of the importation of specific consignments of steamed bone-flour, bone-meal, etc., obtained from factories which have not yet been inspected by the Ministry, provided that each consignment is accompanied by a certificate of a duly authorized officer of the government of the country of origin, stating the name and address of the factory, and which complies with Nos. (2) to (5) of the above-mentioned conditions.

Annex 13

MEDICATED FOOD FOR PSITTACOSIS CONTROL IN PARAKEETS AND PARROTS

Acute psittacosis in parakeets and parrots has been curbed by oral administration of aureomycin in the feed in doses of not less than 100 mg/kg. Interrupted treatment, providing medicated feed for not less than 30 days and if necessary repeated, has ultimately eliminated one carrier state in a parakeet aviary, as proved by sampling of the F_1 to F_4 generations. Psittacosis-free aviaries have been developed by conscientious breeders with chemotherapy and maintained through replacement only with infection-free breeding stock. Introduction of birds from untreated flocks with unknown epizootic history must be strictly avoided, to eliminate any possibility that the infection will be reintroduced. The drug is conveniently administered orally, by feeding hulled millet seeds impregnated with 0.5 mg of aureomycin per g of feed. An interrupted schedule of offering the medicated feed—from three to five days of medicated feed, followed

by regular feed for one or two days, over a period of a total of 30 days of drug intake—has brought about complete, but not always immediate, cures. Success has been achieved only by conscientious aviculturists who maintain high standards of sanitation and isolation.

Several species of parrots have been successfully freed from virus by feeding on the interrupted schedule a mixture of boiled rice and "chicken scratch" feed (corn, wheat and alfalfa meal) with 10 mg of tetracycline per g of mash. Two intramuscular injections of the drug in sesame oil were less efficacious than prolonged oral treatment.

Annex 14

SYSTEM FOR MASS TREATMENT OF DOGS FOR ECHINOCOCCOSIS

The anthelmintic treatment of dogs, as part of a programme against hydatidosis, can be effective only if carried out on a systematic and continuous basis. Treatment should be performed by official personnel, and may be organized either in such a way that dogs are taken to a collection point by the owners, or on the system whereby the mobile field team makes house-to-house visits.

A programme providing for the free anti-echinococcal treatment of all dogs within specified areas was inaugurated in Argentina in 1944. Since that time the work has been carried on rather extensively in several other regions of that Republic and has also been practised in other countries. The methods used in these campaigns may well serve as a guide for similar activity in other parts of the world where canine echinococcosis is enzootic. Although the system described is based upon treatment of dogs at pre-announced collection points, it may easily be adapted for programmes using house-to-house visits.

The first step in this type of endeavour is to give notice to inhabitants of the area concerning the purposes of the campaign and to issue notices of the specified locations to which all dogs should be taken for treatment. It is usually most convenient for owners to assemble their dogs in the morning. The animals should have received no food since the previous evening. At the appointed time, data are obtained from owners or attendants for entry on record forms. As soon as this is done, an assistant places on the dog a collar and chain furnished by the operating crew for use throughout the treatment. The anthelmintic (1% aqueous solution

of arecoline hydrobromide with sugar added) is then given orally with metal syringes or automatic dose-control syringes. The dose used is 10 ml of the 1% solution for large dogs (more than 20 kg), being progressively reduced in accordance with the dogs' weight. The dogs are not actually weighed since their tolerance for arecoline will allow an estimation to suffice, thus making it unnecessary to go through a weighing process, which may excite the animals. Next, a tattoo mark is placed in the ear of the treated animal and the owner is instructed to keep the dog's head lifted for about 10 minutes in order to avoid the vomiting which is sometimes caused by arecoline.

The animals are then allowed to relax and are kept tied to stakes for a period of approximately one hour. If the dog vomits, or if no purgation is observed within 30 minutes after medication, the dose is repeated. Unless purgation occurs, results will be unsatisfactory.

Utmost precautions must be taken in collecting the excrement left by the dogs. This material should be gathered and buried in pits.

It should be added that the period during which dog owners must wait for their animals to be released may very well be used for the purpose of instructing these persons concerning hydatidosis, by means of lectures, demonstrations, motion pictures, etc.

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