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JOINT WHO/FAO EXPERT GROUP ON ZOONOSES

BOVINE TUBERCULOSIS — Q FEVER — ANTHRAX
PSITTACOSIS — HYDATIDOSIS

Report on the First Session

Geneva, 11-16 December 1950

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JOINT WHO/FAO EXPERT GROUP ON ZOONOSES

First Session

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* Unable to attend

World Hlth Org. techn. Rep. Ser. 1951, **40**

JOINT WHO/FAO EXPERT GROUP ON ZOONOSES

Report on the First Session [1]

Following many requests by member nations to WHO and FAO for assistance in the field of zoonoses, a Joint WHO/FAO Expert Group on Zoonoses was organized and met in Geneva, 11–16 December 1950, to formulate recommendations on zoonoses for the guidance of WHO and FAO.

1. INTRODUCTION

Zoonoses are those diseases which are naturally transmitted between vertebrate animals and man. A list of the zoonoses, comprising more than 80 diseases, is contained in Annex 1, page 28. The field of zoonoses is one of the major branches of veterinary public health and includes the etiology, pathogenesis, diagnosis, transmission, and control of these diseases.

Veterinary public health comprises all the community efforts influencing and influenced by the veterinary medical arts and sciences applied to the prevention of disease, protection of life, and promotion of the well-being and efficiency of man.

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[1] The WHO Executive Board, at its seventh session, adopted the following resolution :

The Executive Board

1. NOTES the report of the Joint WHO/FAO Expert Group on Zoonoses on its first session ;

2. THANKS the members of the group for their work ;

3. AUTHORIZES the publication of the report ;

5. CALLS the attention of the competent authorities to the appreciable contributions to public health and national economy which can be effected by practical measures against bovine tuberculosis, hydatidosis, and anthrax, where these diseases are prevalent ;

5. STRESSES the importance of establishing satisfactory arrangements in national administrations so that special attention may be given to animal diseases transmissible to man, and to the inspection and hygiene of foods of animal origin ;

6. AGREES that the World Health Organization, in collaboration with other specialized agencies and international organizations, wherever possible, should undertake further study and co-ordination of international efforts to combat the major zoonoses for which activities have not already been undertaken, particularly the virus encephalitides, tularaemia and leptospirosis ; and

7. REQUESTS the Director-General to provide assistance to governments in combating zoonoses of major public-health and economic importance, in improving food hygiene practices and in the training of personnel for veterinary public-health work.

(Resolution EB7.R78, *Off. Rec. World Hlth Org.* **32**)

Traditionally, veterinary medicine is responsible for the protection of human life against those hazards which result from (*a*) contact with diseased animals, (*b*) consumption of the tissues or products of diseased animals, and (*c*) consumption of animal products contaminated during the processing and delivery of such foods to the consumer. These functions are of basic importance in the public-health programme. The practice of veterinary public health is an important consideration in the attainment of health as defined in the Constitution of WHO : " Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity."

The term " veterinary public health " [2] is relatively new in the English language, but it has already gained wide acceptance. The group feels that the term well describes the modern concepts of the responsibility of veterinary medicine to the health of the public.

The public-health veterinarian is responsible for a variety of duties, which include the following :

(*a*) Promotion of activities to eradicate animal diseases transmissible to man ;

(*b*) Supervision of inspection and hygiene of all foods of animal origin ;

(*c*) Consultation and liaison with voluntary or official agencies, such as farm organizations, professional groups, and health and agriculture departments ;

(*d*) Development of special statistical services with reference to zoonoses ;

(*e*) Research activities in public-health sciences.

The above activities are veterinary public-health functions regardless of the institution or agency which assumes or is charged with the responsibility for their performance. It is not necessary that they should invariably be performed under the direction of a public-health agency. The group feels, however, that these functions can be most effectively pursued by specific administrative units within governmental public-health organizations, whether in economically advanced or in less developed countries.

Effective performance of veterinary public-health services depends upon the employment of properly qualified personnel trained to work as an integral part of a public-health organization. For this reason advanced public-health training is a highly desirable part of the educational background for veterinarians engaged in these activities. Suggested educational qualifications for public-health veterinarians will be found in Annex 2, page 31.

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[2] Some translations recommended by the group are : French — hygiène publique vétérinaire ; Spanish — salud publica veterinaria ; Italian — sanità pubblica veterinaria ; Portuguese — saude publica veterinaria.

2. CONTROL OF TUBERCULOSIS IN CATTLE

In the report of the Expert Committee on Tuberculosis,[3] which held its fifth session in Geneva from 11 to 16 September 1950, the following statement was made:

> " The committee recognizes the seriousness of human infection with bovine tuberculosis in countries where the disease in cattle is prevalent. There is danger of transmission of infection by direct contact between diseased cattle and farm workers and their families, as well as from infected food products.
>
> "... Reduction in bovine tuberculosis helps to improve the economic and nutritional standards of a country by improving the quality of the milk and the productivity of the cattle."

The group fully supports the above statement. The danger from the consumption of infected milk and other food products has long been recognized. It is only recently, however, that the extent of the danger to man, and particularly to children, of acquiring tuberculosis by droplet infection in barns has been widely recognized.[4] It is obvious that the only protection from contact infection is the eradication of bovine tuberculosis.

In the United Kingdom, where bovine-type infection is considered to be important, only about 26% of cases of extra-pulmonary tuberculosis are caused by the bovine type of bacillus.[5] This fact is mentioned because it is often assumed that any case of extra-pulmonary tuberculosis is of the bovine type.

The group wishes to stress the great importance of bovine tuberculosis to a national economy. Although it is difficult to make an exact estimate, the overall productive efficiency of cows infected with tuberculosis may be reduced by 10%-25%.

The cow population of a country or of a herd changes completely, or almost completely, every 6 years. Since it is the adult female that is largely responsible for propagation of bovine tuberculosis and since these animals are the first to leave the herd, one has only to prevent young animals from becoming infected to make drastic reductions of the disease within 6 years.

The method adopted to achieve this end will vary according to:

(1) the incidence of tuberculosis in the country or in the herd;

(2) the methods of husbandry and economic development of the country;

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[3] *World Hlth Org. techn. Rep. Ser.* 1951, **32**, 12

[4] Francis, J. (1950) *Lancet*, **1**, 34

[5] *J. Hyg., Camb.* 1949, **47**, 337

(3) the number of cattle required, and available, for the agricultural economy of the country.

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.

Bovine tuberculosis has been virtually eradicated from several countries of the world and good progress is being made in others. The method adopted in these countries has been the tuberculin-testing of cattle and the removal of the infected from the uninfected animals, thus preventing the spread of infection.

Tuberculin-testing is the basic method of obtaining information on the incidence and distribution of tuberculosis, and an adequate meat-inspection service is an important 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 capita bonus for disease-free herds, and perhaps bonuses or reductions for disease-free or infected carcasses, respectively, can also be effective. Results of control and eradication programmes in various countries are shown in Annex 3, page 33.

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

2.1.1 *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 overall incidence was only about 5%, the incidence in some of the Eastern states was 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, and the group strongly recommends the adoption of this policy where conditions are suitable.

2.1.2 *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 described 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, the great majority are only slightly affected, and they go into other herds that already contain 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 examination of excretions) to detect " open " lesions, particularly cases of pulmonary, uterine, and mammary tuberculosis.[6]

(*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, 70%-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, 10%-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.

2.2 Vaccination

The group stresses that the control and eradication of tuberculosis is best carried out by one of the methods discussed previously, and urges all countries, in which work has not already started, to undertake as early as possible a programme based on one of these procedures to control bovine tuberculosis. In special circumstances, however, consideration might be given to vaccination as a temporary expedient in order to reduce the spread of the disease prior to the development of an eradication scheme.

Various methods of immunizing animals have been used since 1890, but only the use of BCG and the vole acid-fast bacillus need be considered.

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[6] 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.

Most observations, both laboratory and field, have been made with BCG, and the evidence available points to the fact that BCG is capable of increasing the resistance of animals to both natural and artificial infection with bovine tuberculosis. The group feels, however, that it must stress the limitations of the use of vaccination in the control of tuberculosis because :

(*a*) Vaccinated animals react to tuberculin for at least one year. This can interfere with other aspects of the tuberculosis-control programme involving tuberculin-testing and eradication.

(*b*) The intravenous use of BCG vaccine, as observed in the United Kingdom, may cause undesirable systemic reactions in inoculated animals, especially animals in poor bodily condition and those heavily infected with internal parasites.

(*c*) Following subcutaneous use of BCG, large unsightly swellings are frequently produced which might be objectionable to the herd owner. The presence of these swellings, however, provides evidence of the development of increased resistance.

(*d*) Adequate and fresh supplies of carefully prepared BCG vaccine must be available. This is frequently difficult in certain areas and countries.

In spite of these difficulties, the group feels that vaccination might be considered in certain countries with a very high prevalence of disease, and in which economic conditions make it difficult or impossible to embark on a test and elimination programme.

2.2.1 *Use of BCG*

(*a*) Calves shown to be free from tuberculosis should be vaccinated as soon after birth as possible and they must be protected against exposure to natural infection for a period of several weeks after vaccination. Revaccination every six to twelve months is necessary.

(*b*) Vaccinated animals should be protected from exposure to heavy infection. This necessitates the slaughtering of advanced or " open " cases of tuberculosis in the herd and segregation, as far as possible, of infected animals from vaccinated stock.

(*c*) Replacement of reacting older stock by vaccinated animals should be done at the earliest opportunity ; and, subsequently, the replacement of vaccinated stock by non-vaccinated tuberculosis-free animals as soon as replacements are available.

(*d*) The preferred method of vaccination is subcutaneous inoculation of 50-100 mg of moist culture in the dewlap. As mentioned previously, intravenous inoculation has been found to be effective also, and can be used, although systemic reactions should be expected from this method.

2.2.2 *Vole bacillus vaccine*

Experimental observations carried out in the United Kingdom indicate that the injection of living cultures of the vole acid-fast mycobacteria raises the resistance of cattle to tuberculosis. The evidence shows that the duration of resistance following a single injection of the organism is probably longer than that with BCG vaccine, so the interval between vaccinations can be extended to a period longer than is required with BCG. Practical use of the vole bacillus vaccine is not indicated as yet because of the variations still being encountered in the virulence of vole bacillus strains, and difficulties experienced in vaccine production. Further investigations, however, are desirable.

All the work up to date has been done by the intravenous injection of this organism, and systemic reactions, as with BCG, have been observed. There has been no experience of a subcutaneous use of this material.

2.3 Tuberculin and Tuberculin-Testing

2.3.1 *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 trichloracetic 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. It is to be hoped that an international PPD standard tuberculin will be developed. Further work is necessary to develop more satisfactory methods for standardizing the potency of tuberculins. Standard strains of tubercle bacilli should be made available for the production of tuberculin, as there is great variation in their efficiency. An avirulent bovine strain would theoretically be the best for producing mammalian tuberculin for use in cattle. The main tuberculins that have been used, together with notes about them, are summarized in Annex 5, page 38.

At present it is unlikely that all, or indeed a majority of, countries will change to a PPD tuberculin, but the existence of a standard tuberculin will enable countries to compare results and ensure that any new tuberculin is of sufficient potency to detect tuberculosis in cattle.

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.

2.3.2 *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 " [7]

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 animals. 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

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

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. Details of the British and Danish methods are given in Annex 4, page 35, as examples of procedures that may be 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 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. For example, about 5% of animals examined recently in Australia were tuberculous, and about 10% of reacting animals had no visible lesions.[8] If the number of tuberculous animals slaughtered were reduced to 0.5%, as in the USA, the proportion of reacting animals with no visible lesions would automatically increase to about 50% ; again, this is the figure obtained in the USA.

The status of the tuberculin-tests was summarized by Bång[9] 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."

2.4 Summary and Recommendations on Bovine Tuberculosis

The seriousness of bovine-type infection in man, acquired from milk and other animal products, is emphasized. Air-borne infection to attendants in infected barns is also a serious risk. Heat treatment of food products greatly reduces the first risk, but the eradication of bovine tuberculosis is the only means of eliminating the danger of air-borne infection.

The tuberculin-testing of all cattle and the separation of the reactors from the non-reactors is the only method of controlling and virtually eradicating tuberculosis that has proved successful on a large scale.

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[8] See Annex 5, page 38, reproduced from Gregory, T. S. (1949) *Aust. vet. J.* **25,** 17.

[9] Bång, B. (1892) *Ugeskrift for Landmaend,* **6** (translation in *Selected works* (1936) London, p. 268)

All reacting animals may be slaughtered, but this is not necessary in the early stages of a control scheme. Whatever method of segregation is used, the efficiency of the work depends on the performance and interpretation of the tuberculin-test.

Tuberculosis-free herds have been heavily infected from attendants with " open " tuberculosis caused by the bovine type of organisms. Attendants infected with the human type of organism may sensitize cattle to tuberculin and, for this and other reasons, the group recommends that there should be supervision of the health of milkers and attendants.

It is unlikely that any one method of tuberculin-testing will be universally adopted, but it is recommended that standard mammalian and avian PPD tuberculins should be developed. Standard strains of tubercle bacilli, methods of producing tuberculin, and standard tuberculin should be made available.

It is possible that vaccination may assist the progress of eradication under certain conditions in heavily infected herds, but the group recommends that straightforward eradication should be carried out wherever possible.

3. Q FEVER [10]

Q fever, caused by the rickettsia *Coxiella burnetii*, is now recognized as an important public-health problem. Q fever has been reported in man in Australia, England, France, Germany, Greece, Israel, Italy, Panama, Roumania, Spain, Switzerland, Turkey, and the USA. The micro-organism is known to exist in ticks and animals in Algeria, Morocco, and Portugal, in addition to some of the above-named countries. Since the disease has been found in such widely separated localities, it is likely that a search for Q fever in other countries may well reveal its presence there in many instances.

The placentas and milk of infected cattle, sheep, and goats are rich sources of *C. burnetii*, and these domestic animals appear to be the chief sources of human infection. Infection in domestic animals is usually not characterized by observable signs, although occasionally, in sheep and goats, pulmonary affection and abortions may be noted. At the present time the principal means of transmission to man seems to be via the airborne route. Epidemiological evidence also points to the possibility of infection in man through the ingestion of raw or insufficiently heated milk containing the rickettsial micro-organism. It should be noted that some *C. burnetii* may survive commonly used methods of pasteurization of

[10] " Q " stands for " query ". The disease is also known as " Balkan grippe ".

milk, including the heating of milk to 61°C for half an hour, although most of the organisms are killed.

Although much work has been carried on in this disease by various laboratory investigators in the past few years, many gaps remain in our knowledge concerning the epidemiology and epizootiology of Q fever. The group notes, therefore, with satisfaction the following resolution of the Third World Health Assembly : [11]

" In view of the increasing importance of Q fever as a world-wide endemic disease, and

" Recognizing the fundamental role that domestic animals play in the transmission of this disease, and the necessity for clarification of its epidemiology.

" The Third World Health Assembly,

" REQUESTS the Director-General to initiate a preliminary study on the prevalence of Q fever throughout the world and, in collaboration with other specialized agencies and other organizations interested in the problem, to encourage investigations clarifying the epidemiology of this disease with a view to formulating effective control measures."

The group suggests the following approach for implementing this resolution :

(*a*) Local and regional surveys should be undertaken to determine the presence and prevalence of this disease in man and animals. The most useful technique developed until now is the complement-fixation test. In order to make these various surveys comparable, it is recommended that uniform techniques be employed in the performance of the complement-fixation test, and that the same antigen or batches of antigen be used in the different laboratories. It is further recommended that the co-ordination of these studies be carried out under the aegis of WHO with the co-operation of FAO and the Office international des Epizooties (OIE) and that, if possible, the necessary antigen be supplied by these organizations to the various laboratories.[12] Isolation of *C. burnetii* by 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.

(*b*) Research should be encouraged on diagnostic tests other than the complement-fixation test. A more easily performed test than the complement-fixation test would be especially useful in determining the presence of infection in sheep and goats. In this connexion, the promising method reported on an intrapalpebral test in sheep and goats, utilizing the

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[11] Resolution WHA3.25, *Off. Rec. World Hlth Org.* **28,** 23

[12] See also *World Hlth Org. techn. Rep. Ser.* 1950, **23.**

inoculation of dilutions of antigen employed in the complement-fixation test, deserves further study and careful evaluation.

(*c*) Preliminary results on the effectiveness of vaccination procedures in animals are encouraging, and the possibility of artificial immunization in domestic animals should be explored further.

(*d*) Every effort should be made to encourage co-operation between medical and veterinary authorities in the undertaking of epidemiological and epizootiological studies in this disease within a country or region.

(*e*) Further research into the chemotherapy of Q fever in man and animals is desirable. Aureomycin has been reported to be effective in the treatment of human illness, but not in domestic animals.

3.1 Control Measures

The group recognizes the difficulty of advocating adequate control measures for this disease in the present state of our knowledge. Adequate heat treatment of milk and milk products, however, is easily applied and should be performed. In laboratory workers and other individuals liable to heavy exposure to Q fever, it is recommended that vaccination procedures be carried out.

Consideration should be given to the dangers which may arise with the importation of animals from areas where Q fever is enzootic, and to the use of the complement-fixation test for the detection of infected animals.

4. CONTROL OF ANTHRAX IN AGRICULTURE AND INDUSTRY

4.1 Agriculture

The spore form of *Bacillus anthracis* is very resistant to chemical and environmental influences, and can survive for years in contaminated soil and animal products such as hides, hair, and wool. When anthrax infection in livestock becomes established in a district, there is created a relatively permanent enzootic focus of infection because of the inability of the soil, in its biological cycle, to destroy the spores. Repeated epizootics of anthrax over the decades and centuries have resulted in heavy contamination of the soil in many areas of the world, particularly in Asia, southern Europe, and Africa. Parts of North and South America have " anthrax districts ", but the anthrax problem is not as serious in the Western Hemisphere as it is in the Old World.

There is considerable evidence to show that anthrax is introduced into some countries by feeding-stuffs and fertilizers contaminated in ships which have recently conveyed infected bones and hides.

The main sources of infection in agricultural workers are contact infection from contaminated carcasses, wool, hair, and hides, and the ingestion of insufficiently cooked meat derived from infected animals. Respiratory anthrax is rare.

Many factors contribute to the frequency of anthrax infection in man. Despite familiarity on the part 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 found at the beginning of an outbreak. For economic reasons, agricultural workers are loathe 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 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 underdeveloped 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 diagnostic facilities for the diagnosis of anthrax in animals. Rapid presumptive diagnoses can be based upon bacteriological smears and the performance of the Ascoli precipitation test (see Annex 6, page 42). Where facilities are available, culture and animal-inoculation procedures should be used. The meat and by-products of carcasses infected with anthrax should be destroyed on the premises, as far as possible by incineration.

(*b*) Low-cost or free livestock-vaccination programmes undertaken at regular intervals, utilizing biological products of proved potency. In areas where anthrax is highly enzootic, experience has shown that one or multiple doses (depending upon the severity of anthrax in a district) of living spore vaccine of proved potency, repeated annually, is necessary to achieve adequate protection (see Annex 7, page 42).

(*c*) 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, and on the necessity for proper handling and disposal of carcasses. Suspected cases of anthrax in animals should be promptly reported to the responsible authority.

4.2 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 pulmonary and intestinal forms of anthrax occur very rarely. Before the advent of penicillin, even the relatively benign cutaneous form had a mortality-rate of approximately 20%. Early diagnosis and treatment with penicillin have reduced mortality considerably.

The principal sources of anthrax in industrial workers are two groups of animal by-products : (*a*) wool and hair, and (*b*) hides and skins. Nearly all cases of anthrax from handling contaminated hair and wool occur from procedures prior to the weaving and finishing operations ; the spore does not survive the normal dyeing process. Anthrax obtained from hides and skins occurs from handling these materials prior to the tanning and finishing operations.

Goat hair and skins from areas where anthrax is highly enzootic are the greatest sources of human infection.

The greatest source of infection from wool appears to be in coarse wools originating from countries and districts where anthrax is a severe problem. " Grease " wools, even from areas where anthrax is highly enzootic, are not as likely to be contaminated with anthrax spores as are " pulled " wools, since these latter wools might originate from animals dead from anthrax.[13]

The danger of anthrax from coarse wools is closely associated with the processes preliminary to the making of yarn. This danger is considerably diminished following the scouring process which reduces the number of anthrax spores, as well as dirt and extraneous matter adhering to the wool. Also, there is evidence that the lukewarm scouring solutions are conducive to the germination of anthrax spores, and the subsequent high temperatures for drying would be lethal to any vegetative cells. The dyeing of wool in its raw state eliminates the danger of anthrax.

Control recommendations should be made with the view that they do not disrupt greatly the supply of raw materials, or involve a cost out of proportion to the seriousness of the problem.

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[13] " 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.

There are many advocates for the compulsory disinfection of animal products potentially contaminated with anthrax. From an economic point of view, there is no known satisfactory 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 8, page 43). This process if applied on very large imports would be impractical. For small, compact countries where imports are on a modest scale, however, the method can be usefully applied.

The following procedures are recommended in plants where potentially contaminated material is handled: [14]

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

(*b*) 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.

(*c*) All dust, dirt, and sweepings should be burned.

(*d*) In the scouring procedure, the circulation of clean water while draining off the sludge is advisable.

(*e*) Blending of wool should be done after scouring, when this is compatible with the manufacturing process.

(*f*) Drying of the wool should be conducted at the maximum temperature compatible with the process.

(*g*) Dyeing of the raw stock wool should be used as much as possible.

(*h*) 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.

(*i*) 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.

(*j*) Adequate lavatory and locker space should be made available. Two lockers, one for street clothes and the other for work clothes, should be provided for each worker exposed to risk of anthrax. These workers should be required to take showers and change completely from work clothing to street clothing before leaving the factory.

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[14] Wolff, A. H. & Heimann, H. (1951) *Amer. J. Hyg.* **53**, 80

(*k*) 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.

4.2.1 *Infections from bristles*

Numerous cases of anthrax in man have been caused from bristles of shaving and some other brushes contaminated with anthrax spores. It is recommended, therefore, that all bristles to be used for shaving brushes be subjected to sterilization procedures.

4.2.2 *Importation of animal by-products*

Animal by-products, such as wool, hair hides, skins, bones, bone-meal, etc., are frequently contaminated with anthrax and serve as a vehicle 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 group feels, however, that certain measures in connexion with import requirements are feasible and have proved useful in the past, and suggests as a guide the regulations now in effect in the United Kingdom and the USA (see Annex 9, page 43).

5. PSITTACOSIS (ORNITHOSIS) [15]

Psittacosis is a disease of birds and man caused by a virus of the psittacosis-lymphogranuloma group. Infections are found in psittacine birds, pigeons, ducks, canaries, chickens, turkeys, and other birds. The disease is worldwide in distribution, with the highest reported prevalence in North America.

Enzootic psittacosis in parrots, parakeets, pigeons, ducks, or other birds usually takes the form of an asymptomatic disease, although occasionally signs of illness can be recognized. The acute form of the disease, when it occurs, usually affects young birds.

Most human cases have been traced to close contact with psittacine birds in the home or aviaries, although in recent years some areas have been able to account for exposure to these birds in only 50% of the reported human cases. There is considerable evidence that a high prevalence of infection exists in free-flying pigeons, but few human cases have been

[15] The group prefers the use of the term " psittacosis " to cover the disease in man and all species of birds.

attributed to these birds, in distinction to the more common occurrence of infection derived from loft and racing pigeons. Human cases traced to ducks are few in number. Chickens and, recently, turkeys have been the cause of human infection. Infection is very common in laboratory workers occupied with this disease.

The complement-fixation test is a valuable procedure in the detection of psittacosis in man or birds, although the difficulties of utilizing this test in birds are recognized. The mouse-inoculation test is recommended for confirmatory diagnosis. Java rice birds (*Munia oryzivora*), which are very susceptible to this disease, can be used for the detection of psittacosis in aviaries.

The lasting immunization of birds with vaccines has not yet been achieved. Antibiotics have failed in the treatment of carriers.

During the past 20 years there have been various control procedures instituted throughout the world which prohibit the importation of members of the psittacine family; some countries make exceptions for zoological parks, scientific institutes, or personal pets. Attempts have been made to control the psittacine bird-breeding industry by internal regulations. These measures were necessary during the period when the case fatality-rate was high, and the disease was attributed solely to psittacine birds; but with the additional evidence that the disease has many other bird reservoirs, the worldwide drop in the incidence of human cases, and the lower human mortality-rate, it is felt that national quarantine policies should be re-examined. It is recommended that the importation of commercial shipments of psittacine birds be prohibited, but that consideration should be given to allow individuals to import pets, rare birds, and exceptional breeding-stock, 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, whereupon two birds can be allowed in a cage. It is further recommended that WHO keep all countries informed of the disease status in the world.

6. HYDATIDOSIS

Hydatid disease is a world problem, recognized in varying degrees on every continent. The areas of the world with the greatest known incidence are southern South America and parts of Oceania. The disease is also of considerable importance in the Mediterranean littoral. Areas with somewhat lesser, or intermediate, incidence are Central Europe, the Middle East, and parts of northern South America. Available data indicate that the disease is of somewhat minor importance in other areas. It should be noted, however, that recent studies have shown that the disease is spreading from major foci of infection, and also that new foci have been discovered in regions heretofore believed free from the disease. The Third World Health Assembly took cognizance of this problem in the following resolution : [16]

> " The Third World Health Assembly
>
> " 1. NOTES the importance of hydatidosis in certain areas of the world, both as a human infection and as a cause of losses in food supplies, and
>
> " 2. REQUESTS the Director-General, in co-operation with other specialized agencies and organizations, wherever possible, to lend technical assistance for its eradication or for research upon request of government authorities."

Hydatidosis finds the ideal ecology in areas where sheep and dogs abound. Yet the cycle of the parasite is also maintained with other domestic livestock as the intermediate host, and is perpetuated in districts where it is common practice that cattle, swine, or goats are maintained in association with domestic or wild Canidae. It must be noted, too, that the cycle of the parasite may be maintained completely in wildlife.

The disease is most often transmitted to man directly from the dog, but it must be emphasized that indirect transmission from dog to man via foodstuffs or other contaminated materials is a real danger.

The major efforts in the campaign against hydatidosis must be directed towards reducing the disease in its animal reservoir. Since the dog, infected with *Echinococcus granulosis*, is the common transmitting host of hydatid disease, control measures should be designed to minimize and eventually eliminate such canine infection. 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 reduced there to one of very minor importance. This improvement 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 once annually.

An antihydatidosis programme may be conveniently considered under the following headings :

(1) Eradication of canine infection by
- (*a*) anthelmintic treatment
- (*b*) stray-dog elimination

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[16] Resolution WHA3.23, *Off. Rec. World Hlth Org.* **28**, 23

(2) Prophylactic measures against canine reinfection.

These various aspects of hydatidosis control should be pursued concomitantly if the programme is to be successful. It is obviously useless to treat dogs for echinococcal infection if the same dogs may gain access to cystic offal and promptly become reinfected.

6.1 Eradication of Canine Infection

6.1.1 *Anthelmintic treatment*

The practical elimination of canine echinococcosis is accomplished by treatment with arecoline hydrobromide. This drug has been used as an anthelmintic for many years, and gives excellent results. On the basis of vast experience in South America, the recommended dose is 4 mg per kg of body-weight. Various methods have been used in administering 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, as extensively used in South America, is described in Annex 10, page 46.

6.1.2 *Stray-dog elimination*

The elimination of ownerless dogs is a very important part of the antihydatidosis campaign, as well as of the fight against such diseases as rabies. The effectiveness of the plan to eliminate unclaimed animals is dependent, first, upon the practicability of the laws and regulations pertaining thereto and, secondly, upon the enthusiasm of the enforcement agency. Proper facilities for apprehending and impounding the strays are, of course, basic requirements.

6.1.3 *Reduction of wild Canidae population*

Since wild animals of the canine family, such as wolves, jackals, and foxes, are known to harbour the adult parasite, measures for reducing the population of these animals should be adopted in enzootic areas.

6.2 Prophylactic Measures against Canine Reinfection

Improved practices of slaughtering livestock, with appropriate methods of offal disposal, are the keystone of hydatidosis eradication ; it 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 problems created by the existence of very small abattoirs and farm slaughtering for home consumption. Complete centralization of slaughtering operations is economically impracticable in many sparsely settled areas. Furthermore, it is unrealistic to expect governments to provide constant technical inspection and supervision of rural slaughtering. Success in this aspect of hydatidosis eradication must, therefore, depend largely upon the development in rural butchers of a greater sense of responsibility. This becomes a matter of rural education concerning public health and animal hygiene.

6.3 Prevention of Human Infection

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 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. Audio-visual aids, such as slide films, motion pictures, dramatizations, exhibits, demonstrations, booklets, etc., are especially useful in explaining the dangers of an environment contaminated with the eggs of " hydatid worms ". The group recommends that these measures be directed particularly towards children of school age.

7. INTERNATIONAL ACTION INDICATED FOR STUDY AND CONTROL OF OTHER MAJOR ZOONOSES

The group notes that two of the major zoonoses, rabies [17] and brucellosis,[18] have already been considered in detail by WHO and FAO/WHO expert groups, and supports strongly the recommendations contained in the reports on these subjects. In addition to the lines of activity indicated in the reports on rabies and brucellosis, as well as those connected with the diseases discussed in the present report, the group would like to point out that international action concerning several other major zoonoses

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[17] *World Hlth Org. techn. Rep. Ser.* 1950, **28**

[18] *World Hlth Org. techn. Rep. Ser.* 1951, **37**

is greatly needed, and recommends that these topics be given active consideration in the programmes of WHO and FAO at the earliest opportunity. The group further recommends that the following topics be included on the agenda of the second session of the Joint WHO/FAO Expert Group on Zoonoses.

7.1 Virus Encephalitides

The spread of eastern, western, and Venezuelan types of equine encephalomyelitis, and Japanese B and other virus encephalitides, is an ever-present danger. The group recommends, therefore, that studies be undertaken to determine the prevalence of these diseases in enzootic areas, and that medical and veterinary authorities and diagnostic laboratories in countries now believed to be free from these diseases be kept informed of their current status from the standpoint of foci of infection, and be given technical information with respect to the recognition and identification of the diseases. For this latter purpose, assistance to laboratories by WHO and FAO in the exchange of virus strains, typing sera, and information on technical procedures is strongly urged.

7.2 Leptospirosis

In addition to dogs, rodents, and swine, cattle have been demonstrated recently to provide an important source of infection for human beings. The group recommends that surveys on this disease be carried out in all countries with the assistance of WHO and FAO. The assistance should include technical advice and co-ordination of research activities. Attempts should be made to achieve uniformity in nomenclature and procedures for typing the various strains of Leptospira.

7.3 Tularaemia

The spread of this disease to countries and areas previously free from tularaemia is a cause for serious concern. The group recommends that studies be undertaken to define more clearly the areas of infection and the transmission of this disease from reservoirs in rodents and domestic animals.

7.4 Bilharziasis

The role of animals as reservoirs of this disease needs clarification, and the group recommends that studies in this subject be undertaken in enzootic areas. In this connexion, the danger of dogs conveying this disease to hitherto free areas should be given particular attention.

7.5 Trichinosis

An evaluation of the various methods used for the control of trichinosis would be highly useful preparatory to the formulation of practical recommendations on this disease by the group at its second session.

7.6 Glanders

The group recommends that all assistance possible be given by FAO and WHO to countries where this disease is present, in order to eradicate the disease completely.

7.7 Salmonellosis

Transmission of this disease directly from animal reservoirs and through food products to man is a serious problem. Further study on these aspects of salmonellosis is strongly indicated. In this connexion, the group would like to call attention to the facilities for typing of *Salmonella* which are available at the International Salmonella Centre, Copenhagen, and at other salmonella centres throughout the world, and urges their greater use by veterinary and medical authorities.

7.8 Other Diseases

The possible role played by animals in the transmission to human beings of influenza, histoplasmosis, and toxoplasmosis is worthy of careful study. The importance of animals in many of the parasitic and fungus infections listed in Annex 1, page 28 should be explored and the importance of these infections in various countries be more clearly determined.

7.9 Food Hygiene

The group urges that this important branch of veterinary public health be given early and detailed attention by WHO and FAO. The transmission of disease to human beings from food of animal origin is of basic importance to all countries, and, in particular, to those countries where long-range programmes of economic development are being initiated. Technical advice and assistance in food-hygiene practices would be of great importance to economically underdeveloped countries both from the standpoint of protecting man from food-borne disease and in preventing unnecessary losses of vitally needed food supplies.

7.10 Veterinary Education and Fellowships

The group strongly recommends that WHO and FAO provide assistance where needed to veterinary schools and institutes by means of technical guidance and, where possible, teaching equipment and supplies for educational, diagnostic, and research activities. The group stresses the importance of fellowships for study in the field of veterinary public health and urges that these fellowships be provided by WHO and FAO to augment the greatly needed forces of veterinarians especially trained in this field.

8. INTERNATIONAL SANITARY AND QUARANTINE MEASURES AGAINST ZOONOSES

The work of the Expert Committee on International Epidemiology and Quarantine on the preparation of draft regulations was brought to the notice of the group, who considered the possibility of the application of similar principles and machinery in respect of the prevention of transmission of disease by importation of animals and birds.

It would appear difficult to frame regulations acceptable to all countries since while certain countries may be desirous of imposing the most stringent regulations, even total prohibition, others are not always able to do so for economic reasons or because of the urgent necessity of obtaining supplies of animals and animal products to meet the nutritional requirements of the countries.

The matter is, however, one worthy of further consideration. The public-health problem should be studied further to determine which zoonoses are of significance, and to which international control might be applicable. It is recommended that WHO, FAO, and OIE study these problems jointly and prepare a report for the second session of the Joint WHO/FAO Expert Group on Zoonoses.

The group considers that the following ten diseases or groups of diseases are of sufficient importance to warrant further study to determine

(*a*) their international incidence ;

(*b*) the possibility of their control by international regulation.

1. Virus encephalitides
2. Rabies
3. Psittacosis
4. Q fever
5. Leptospirosis
6. Tularaemia
7. Leishmaniasis
8. Bilharziasis
9. Trichinosis
10. Hydatidosis

9. VETERINARY BIOLOGICAL PRODUCTS

The diagnosis of some diseases of animals, and their successful prevention and treatment, depend largely upon the use of satisfactory biological products. To ensure that such products are of efficient quality, recognized and agreed standards should be available with which to compare them.

Efforts are now being made in some countries to prepare standards for biological products and to introduce legislation concerning them.

It is important that standards for biological products should be international rather than national, and that advantage should be taken of any information now available on standards used in human medicine and, further, that there should be a close association between veterinary and medical workers in this field.

With this end in view, the group recommends that every effort should be made to correlate work on the standardization of biological products now in progress, and to be developed, in organizations dealing with such products for both human and veterinary use.

Annex 1

SOME DISEASES NATURALLY TRANSMITTED BETWEEN VERTEBRATE ANIMALS AND MAN

Disease	*Causative organism*	*Principal animals involved*
	1. Virus Diseases	
Arthropod-borne virus encephalitides		
(*a*) St. Louis	St. Louis virus	birds
(*b*) Eastern equine	Eastern equine virus	birds, equines
(*c*) Western equine	Western equine virus	birds, equines
(*d*) Venezuela equine	Venezuela equine virus	equines
(*e*) Japanese B	Japanese B virus	horses and other mammals
(*f*) Russian far-eastern	Russian far-eastern virus	wild mammals, birds
*(*g*) Louping-ill (infectious encephalomyelitis of sheep)	Louping-ill virus	sheep
*(*h*) B virus	B virus	monkeys
*Aujeszky's disease (pseudorabies)	Aujeszky's virus	ruminants, swine, dogs
Cowpox	Vaccinia virus	cattle
*Equine infectious anaemia	Equine infectious anaemia virus	equines
*Foot-and-mouth disease	Foot-and-mouth disease virus	ruminants, swine
Lymphocytic choriomeningitis	Lymphocytic choriomeningitis virus	mice, dogs, monkeys
*Newcastle disease	Newcastle disease virus	chickens
*Ovine pustular dermatitis (contagious ecthyma)	Ovine pustular dermatitis virus	sheep
Psittacosis (ornithosis)	Psittacosis virus	psittacines, pigeons
Rabies	Rabies virus	dogs, cats, wolves, foxes, jackals, bats
Rift Valley fever (enzootic hepatitis of sheep)	Rift Valley fever virus	sheep
*Vesicular stomatitis	Vesicular stomatitis virus	equines, cattle, swine
Yellow fever (jungle)	Yellow fever virus	monkeys
	2. Rickettsial Diseases	
Boutonneuse fever	*Rickettsia conorii*	dogs
Endemic (murine) typhus	*Rickettsia typhi*	rodents
Q fever	*Coxiella burnetii*	cattle, sheep, goats, bandicoots
Rocky mountain spotted fever	*Rickettsia rickettsii*	rodents, dogs

* Only occasional or rare infections reported in man.

Disease	*Causative organism*	*Principal animals involved*
*Rickettsialpox	*Rickettsia akari*	mice
South African tickbite fever	*Rickettsia rickettsii* var. *pijperii*	dogs
Tsutsugamushi fever (scrub typhus)	*Rickettsia tsutsugamushi*	rodents

3. Bacterial Diseases

Anthrax	*Bacillus anthracis*	mammals
Brucellosis	*Brucella abortus, Br. suis, Br. melitensis*	cattle, swine, goats, sheep
Diphtheria	*Corynebacterium diphtheriae*	cows
Erysipeloid	*Erysipelothrix rhusiopathiae*	swine, birds, mice, fish
Glanders	*Malleomyces mallei*	equines
Leptospirosis	*Leptospira* sp.	rodents, swine, dogs, cattle
Listeriasis (listerellosis)	*Listeria monocytogenes*	rodents, sheep, cattle, swine
Melioidosis	*Malleomyo s pseudomallei*	rodents
Pasteurellosis	*Pasteurella multocida*	ruminants, cats, birds
Plague	*Pasteurella pestis*	rats and other rodents
*Pseudotuberculosis	*Pasteurella pseudotuberculosis*	rodents, birds
Rat-bite fever	*Spirillum minus*	rat
	Streptobacillus moniliformis	rat
Relapsing fever	*Borrelia* sp.	rodents
Salmonellosis	*Salmonella* sp.	mammals, birds
Shigellosis	*Shigella dysenteriae*	dogs
Staphylococcosis	*Staphylococcus* sp.	mammals
Streptococcosis	*Streptococcus* sp.	mammals
Tuberculosis	*Mycobacterium tuberculosis*	
	var. *bovis*	cattle
	var. *hominis*	dogs, monkeys
	*var. *avium*	birds, swine
Tularaemia	*Pasteurella tularense*	rodents
*Vibrio abortion	*Vibrio foetus*	sheep, cattle

4. Fungus Diseases

*Epizootic lymphangitis	*Blastomyces farciminosus*	equines
Ringworm	*Trichophyton* sp.	horses, cattle
	Microsporum sp.	dogs, cats

5. Protozoal Diseases

Amoebic dysentery	*Endamoeba histolytica*	dogs, monkeys
†Balantidiosis	*Balantidium coli*	swine

* Only occasional or rare infections reported in man.

† Only occasional or rare infections reported in man; for further parasitic diseases in this category see Wright, W. H. (1947) *Ann. N.Y. Acad. Sci.* **48**, 553.

Disease	*Causative organism*	*Principal animals involved*
Leishmaniasis		
Espundia	*Leishmania braziliensis*	dogs, cats, rodents
Kala-azar	*Leishmania donovani*	dogs, cats, rodents
Oriental sore	*Leishmania tropica*	dogs, cats, rodents
Trypanosomiasis		
African sleeping sickness	*Trypanosoma rhodesiense (= brucei?)*	wild game
	Trypanosoma gambiense	wild and domestic animals (ruminants)
Chagas' disease	*Trypanosoma cruzi*	cats, dogs rodents

6. Helminth Diseases

(*a*) Trematode diseases	*Clonorchis sinensis*	cats, dogs, swine
	†*Dicrocoelium dendriticum*	ruminants, equines
	Echinostoma sp.	cats, dogs, rodents
	†*Fasciola hepatica*	ruminants
	Fasciolopsis buski	swine
	Gastrodiscus hominis	swine, rats
	Heterophyes heterophyes	cats, dogs
	Opisthorchis felineus	cats, dogs
	Paragonimus westermani	dogs, cats, swine, rodents, wild carnivores
	Schistosoma japonicum (and occasionally other species)	ruminants, swine, dogs, cats
(*b*) Cestode diseases	†*Coenurus cerebralis*	dogs, sheep
	Cysticercus cellulosae	swine
	Diphyllobothrium latum	fish, carnivores
	†*Dipylidium caninum*	dogs, cats
	Echinococcus granulosus (hydatid stage)	dogs, ruminants, swine, wild carnivores
	Hymenolepis nana (and occasionally other species)	rats, mice
	Sparganum mansonoides (and other species)	cats, mice
	Taenia saginata	cattle
	Taenia solium	swine
(*c*) Nematode diseases	*Ancylostoma braziliense* (and occasionally other species)	dogs, cats
	†*Capillaria hepatica*	rodents, monkeys, dogs
	†*Dioctophyme renale*	dogs, fish
	†*Dracunculis medinensis*	dogs, horses, cattle
	†*Gnathostoma spinigerum* (and other species)	cats, dogs, fish, wild carnivores

† Only occasional or rare infections reported in man ; for further parasitic diseases in this category see Wright, W. H. (1947) *Ann. N.Y. Acad. Sci.* **48**, 553.

Disease	*Causative organism*	*Principal animals involved*
(*c*) Nematode diseases (*continued*)	†*Metastrongylus apri*	swine
	Strongyloides stercoralis (and occasionally other species)	dogs
	†*Toxocara cati*	cats
	Trichinella spiralis	swine, rodents, wild carnivores
	Trichostrongylus colubriformis (and occasionally other species)	ruminants

7. Arthropod and insect diseases

Bug-bites	*Cimex lectularius* (and other species)	chickens
Chicken-mite itch	*Dermanyssus gallinae* (and occasionally other mites)	chickens
Flea-bites	*Xenopsylla*, *Ctenocephalus*, *Ceratophyllus*, *Tunga*, etc.	rats, dogs, cats, swine, birds
Myiasis	*Oestrus*, *Hypoderma*, *Gasterophilus*, *Cochliomyia*, etc.	ruminants, equines
Tick-bites	*Ixodes*, *Dermacentor*, *Rhipicephalus*, *Haemophysalis*, *Amblyomma*, *Argus*, etc.	rodents, dogs, ruminants, equines
†" Tongue worm "	*Linguatula serrata*	dogs, cattle

† Only occasional or rare infections reported in man ; for further parasitic diseases in this category see Wright, W. H. (1947) *Ann. N.Y. Acad. Sci.* **48**, 553.

Annex 2

TRAINING OF PUBLIC-HEALTH VETERINARIANS

The basic educational background for the public-health veterinarian should be as follows :

1. Pre-veterinary training in the sciences and humanities as required to enter a school of veterinary medicine.

2. Completion of a course leading to a degree in veterinary medicine from a school of recognized standing.

The candidate for a public-health degree will have had the benefits of fundamental training in veterinary medicine prior to admission, and therefore his efforts should be directed towards obtaining professional public-health education. The broadening influence of contact with other professions interested in the field of public health, with opportunity for free interchange of ideas, is of inestimable value to the veterinarian. Such opportunity is available in a school of public health.

Experience, training, and graduate education for the public-health veterinarian should include the following :

(1) Supervised experience in meat, milk, and poultry inspection.

(2) Supervised field training in a health department for a sufficient period of time to acquaint the candidate with public health and give him an opportunity to determine whether he is suited for the work.

(3) Completion of a programme of study in a school of public health. The training for public-health veterinarians in a school of public health should include two phases :

(*a*) Instruction in the general principles and practice of public health so that the veterinarian will have full understanding and be able to contribute to an overall health programme. Such training will facilitate his understanding of the problems of other professional groups in public health and enable him to define his own activities more clearly. This phase of instruction should cover the general field of public-health administration and practice, biostatistics, public-health economics, health education, and public-health laws ; it should be accompanied by special instruction in the application of basic principles to the functions and duties of a public-health administrator.

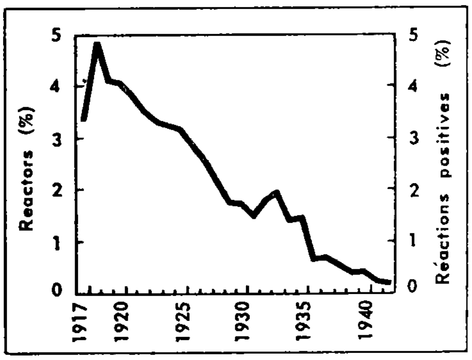
(*b*) Instruction in specialized fields which are of particular importance to the practice of veterinary public health such as epidemiology, food hygiene, sanitary science, bacteriology, parasitology, immunology, virology, tropical medicine, medical entomology, and nutrition. As specialized curricula in veterinary public health are developed, they should emphasize animal diseases communicable to man and their epizootiology, in addition to the courses mentioned above. Satisfactory completion of one academic year of graduate study, with sufficient supervised practical field experience to satisfy the administrative officer or committee of the school of public health, may be considered the usual time requirement. The veterinarian should be considered eligible to receive the same degrees in public health as are offered to medical and other public-health officers.

Graduate education of veterinarians in schools other than schools of public health, leading to a Master of Science, Doctor of Science, Doctor of Philosophy, or other advanced degree, would be acceptable in certain cases ; it should be shown, however, that the major emphasis of study has direct application in public health, viz., training in bacteriology, pathology, and parasitology. The optimal preparation for veterinarians primarily concerned with the laboratory and research phases of public health is in training leading to degrees in science or philosophy rather than in a curriculum which includes administrative training.

Annex 3

PROGRESS IN CONTROL OF BOVINE TUBERCULOSIS IN COUNTRIES USING DIFFERENT METHODS *

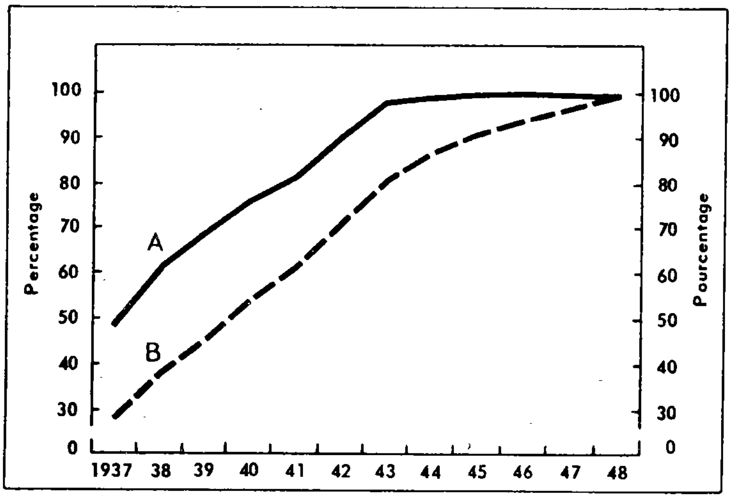
FIG. 1. CONTROL OF BOVINE TUBERCULOSIS IN THE USA: TEST AND SLAUGHTER METHOD



The number of cattle tested between 1917 and 1942 was about 253 million; by 1949 this figure had reached 313 million. There were nearly 4 million reactors.

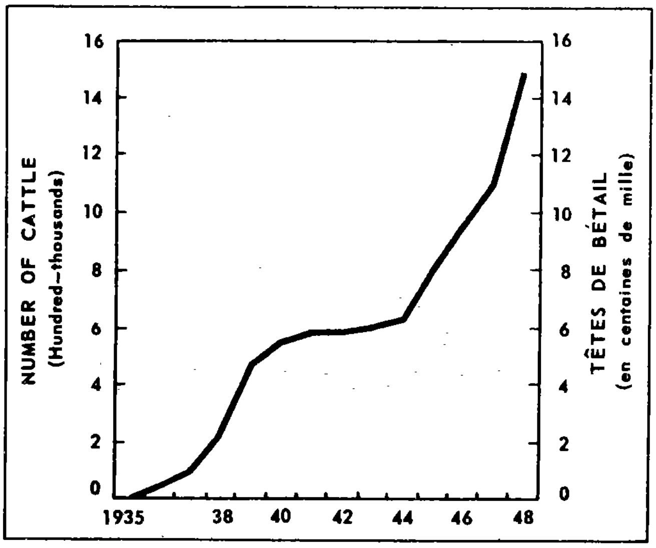
* These figures are taken from Francis, J. (1950) *Lancet*, **1**, 34.

FIG. 2. CONTROL OF BOVINE TUBERCULOSIS IN DENMARK: MODIFIED ERADICATION METHOD



A = total herds tested
B = tested herds free from tuberculosis

FIG. 3. PROGRESS OF THE ATTESTED HERDS SCHEME IN THE UNITED KINGDOM



By 1950, over 2 million cattle were in attested herds.

Annex 4

TUBERCULIN-TESTING

British method — single intradermal comparative test

Mammalian tuberculin containing 3.0 mg PPD per ml, and an avian tuberculin containing 0.8 mg PPD per ml are used at doses of 0.1 ml.[1] They are both injected in the middle third of one side of the neck on a line parallel to the spine of the scapula ; avian tuberculin is injected about four inches below the crest of the neck, and the mammalian tuberculin about five inches below the avian type. These sites are carefully defined because sensitivity of the skin to tuberculin is not the same in all parts of the neck. The thickness of a fold of skin is measured with calipers before the first injection and again 72 hours later. The interpretation of the test adopted by the Animal Health Division of the Ministry of Agriculture and Fisheries is based on a very large number of trials followed by postmortem examinations of doubtful reactors.[2] Murphy[3] carried out the test on 50 animals which were then subjected to a postmortem examination. The results indicated that the test was reliable and practitioners have found it reliable for the eradication of tuberculosis from herds.[4] The following points of interpretation are taken from Boddie,[5] whose book contains a fully detailed account of the test.

An increase in skin thickness of 2 mm or less at the site of injection of either tuberculin is taken as a negative reaction, 4 mm or more as a positive reaction, and 3 mm a doubtful reaction. The character of the swelling is also noted, a diffuse swelling being of more significance than a circumscribed swelling. The presence in the herd of animals giving a positive reaction to avian tuberculin and a negative reaction to mammalian tuberculin can be taken as evidence of the existence of non-specific infection in the herd.

All animals giving a negative reaction to mammalian tuberculin may be retained in a clean herd, and under certain conditions those giving doubtful or positive reactions to tuberculin may be isolated for retest or

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[1] For retesting animals which give a suspicious or doubtful reaction, 1.5 mg and 0.4 mg PPD per ml of mammalian and avian tuberculin respectively are used. It is planned in the near future to use 2.0 mg PPD per ml of mammalian tuberculin for both original and retesting purposes. Careful studies have shown that 2.0 mg PPD per ml is equivalent to the present international standard of Old Tuberculin. For avian tuberculin a uniform strength of 0.5 mg PPD per ml will be used.

[2] *Vet. Rec.* 1947, **59,** 95

[3] Murphy, J. M. (1945) *Vet. Rec.* **57,** 356

[4] Ritchie, J. N. (1942) *Vet. Rec.* **54,** 395

[5] Boddie, G. F. (1950) *Veterinary diagnosis*, Edinburgh, p. 271

even retained in a herd as being free from bovine tuberculosis. If the presence of infection other than mammalian tuberculosis, i.e. " non-specific " infection, has not been established, animals in which the mammalian reaction exceeds the avian by not more than 4 mm are isolated and retested ; if the difference is greater than 4 mm the animals are discarded. If the presence of " non-specific " infection has been established, animals can be retained in the herd if the mammalian reaction does not exceed the avian by more than 4 mm. If the difference is more than 4 mm but less than 6 mm, animals are isolated and retested ; if the mammalian reaction exceeds the avian by more than 6 mm the animals are discarded.

The test should always be interpreted as though avian infection was not present in the herd if the existence of a large number of mammalian reactors is found, even though the comparative test indicates the presence of an avian infection as well as the bovine infection. It will be appreciated that the interpretation of the comparative test may present considerable difficulties, but a guiding principle in interpretation is that no animal must be retained in the herd about which there can be any ground for suspicion. In order to ensure ultimate success in the eradication of tuberculosis such an animal must be isolated and retested and should only be returned to the herd when a retest clearly indicates that it is free from mammalian infection.

Danish method

The tests must be performed only with tuberculin distributed by the State Veterinary Serum Laboratory, Copenhagen. The intradermal test must be employed; exceptions are made upon special permission from the veterinary directorate. The injection should be given immediately in front of, or just behind, the shoulder. The thickness of the skin is measured with an authorized instrument before and 72 hours after the injection, the difference between the measurements being recorded as the reaction value. The measurements must be recorded at once.

In appraising the reaction, consideration must be given to whether or not the herd is free from tuberculosis.

In hitherto tuberculosis-free herds, animals with a reaction value not exceeding 2.5 mm are considered healthy. Animals with a reaction value over 2.5 mm must be tested again with bovine and avian tuberculins simultaneously. If the reaction to the avian tuberculin is considerably greater than that to the bovine, the animal is regarded as not infected with bovine tuberculosis. In doubtful cases the double test must be repeated after two months.

In all other herds, animals with a reaction value of 3.5 mm or more are regarded as infected with bovine tuberculosis. Animals with reaction values of 2.0-3.0 mm are considered suspect. Under certain stipulated circumstances the test on such animals may be repeated.

Only veterinary surgeons are allowed to perform tuberculin-tests.

Non-specific sensitization

The problems associated with non-specific sensitization are discussed by Francis.[6] Gregory[7] summarizes recent trends in research on tuberculin and shows that even in one country there is not complete agreement on the method to be adopted. There is at present no agreement in Australia as to whether the intradermal test should be read after 72 or after 96 hours. The skin of the neck is probably a more sensitive and satisfactory site for the test than the caudal fold, but it would be very difficult to use this site under Australian conditions. There is little evidence that avian tuberculosis, Johne's disease, " skin lesions ", or sensitization from human cases are important causes of non-specific sensitization in Australia.

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[6] Francis, J. (1947) *Bovine tuberculosis*, London, p. 141
[7] Gregory, T. S. (1949) *Aust. vet. J.* **25,** 138

Annex 5

DETAILS OF TUBERCULINS THAT HAVE BEEN USED *

Country	Tuberculin	Prepared from	Culture medium	Potency	Type of test
Australia	CSL (heat concentration)	human strains	synthetic	approximately 1½ OT standard	single intradermal
Canada (*a*)	HAD (heat concentration)	bovine strain	synthetic	about half Canada (*b*)	single intradermal
Canada (*b*)	BAI (heat concentration)	human strains	synthetic	almost twice Canada (*a*); probably equals OT standard	single intradermal
England (*a*)	CT (ammonium sulfate precipitation)	bovine and human strains	synthetic	about ¼ OT standard	double intradermal
England (*b*)	Weybridge tuberculin (heat concentration BAI type)	human strains	synthetic	approximately equal to OT standard	double intradermal

OT = Old Tuberculin
PPD = purified protein derivative
BAI = US Bureau of Animal Industry
CSL = Commonwealth Serum Laboratory, Australia
NVL = non-visible lesion
HAD = Health of Animals Division

* This table is taken from Gregory, T. S. (1949) *Aust. vet. J.* **25,** 22

First dose	Interval between doses	Second dose	Site of inoculation	Remarks
approxi-mately 0.05 ml	—	—	caudal fold	Used in eradication work in Australia since 1939
0.05 ml	—	—	caudal fold	Used in eradication work for many years Misses more tuberculous animals than Canada (*b*) but fewer NVL reactors
0.05 ml	—	—	caudal fold	Detected more tuberculous animals than Canada (*a*), but more NVL reactors Use discontinued
0.1 ml	48 hours	0.1 ml	neck	Widely used in eradication work in the UK prior to 1940 Too many tuberculous animals missed
0.1 ml	48 hours	0.1 ml	neck	More potent than England (*a*) More tuberculous animals detected Too many NVL reactors Necessitated introduction of comparative test

Country	Tuberculin	Prepared from	Culture medium	Potency	Type of test
England (*c*)	Weybridge mammalian PPD (trichloracetic acid precipitation)	human strains	synthetic	¾ OT standard (1.5 mg PPD per ml)	double intradermal
	Weybridge avian PPD (trichloracetic acid precipitation)	avian strains	synthetic	(0.4 mg PPD per ml)	double intradermal
England (*d*)	Weybridge mammalian PPD	human strains	synthetic	1½ OT standard (3.0 mg PPD per ml)	single intradermal
	Weybridge avian PPD	avian strains	synthetic	(0.8 mg PPD per ml)	single intradermal
Northern Ireland	Weybridge mammalian PPD	human strains	synthetic	¾ OT standard (1.5 mg PPD per ml)	" Stor-mont " intradermal (modified double)
USA	BAI (Serial F)	human strains	synthetic	equals or somewhat exceeds OT standard	single intradermal

OT = Old Tuberculin
PPD = purified protein derivative
BAI = US Bureau of Animal Industry
CSL = Commonwealth Serum Laboratory, Australia
NVL = non-visible lesion
HAD = Health of Animals Division

First dose	Interval between doses	Second dose	Site of inoculation	Remarks
0.1 ml	48 hours	0.1 ml	neck	Used extensively since 1942 in eradication work Less potent than England (*b*) Satisfactory in comparative test
0.1 ml	48 hours	0.1 ml	neck	Note lower concentration of PPD Serves to distinguish non-specific reactors in comparative test
0.1 ml	—		neck	Introduced in 1947 instead of double intradermal test, as first test strength, but England (*c*) used for re-tests
0.1 ml	—	—	neck	Used in first tests as above, but England (*c*) used for re-tests
0.1 ml	7 days	0.1 ml	neck	In early trials selected autopsy-positive from autopsy-negative animals with average error of 1.8% as compared with 18.9% in single intradermal test (neck) No comparative test necessary
0.05 ml	—		caudal fold and vulva	Replaced OT dilution of approximately 1/4 potency Used in eradication work since 1935 Called " double intradermal " in USA, because two separate injections made simultaneously

Annex 6

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, 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, filtered, and the clear filtrate is stratified with precipitating serum of known potency.

Annex 7

ANTHRAX VACCINE

Many different preparations of anthrax spore vaccines are useful for the prevention of this disease in animals, particularly spore suspensions in glycerine-saline solution for intradermic use and spore suspensions in saponin solution for subcutaneous use. The avirulent, non-capsulated strain of *B. anthracis* used in the spore vaccine developed at the Onderstepoort Veterinary Research Laboratory, Pretoria, Union of South Africa, has been used with considerable success in many countries. It should be emphasized, however, that in heavily contaminated districts multiple inoculations of vaccine, regardless of their effectiveness in single doses elsewhere, are usually necessary in order to obtain adequate protection.

It should also be noted that the strength of different preparations of saponin varies widely. Each batch of saponin should be tested by inoculating sheep subcutaneously with progressive dilutions of saponin. The dilution which causes a slight local oedema should be selected for the purposes of vaccine preparation.

Details of the preparation of anthrax vaccine are available to government authorities upon request to FAO and WHO.

Annex 8

OUTLINE OF WOOL-STERILIZATION PROCESS

The United Kingdom is the only country which sterilizes all hair from dangerous sources. The process is conducted at a central sterilization plant in Liverpool. The process which uses modified scouring vats is described below.

The hair or wool is washed for 10 minutes in 0.5% sodium carbonate solution at 37.8°C. This is followed by another washing in 3.5% soap solution for 10 minutes at 37.8°C. The third step is a ten-minute exposure to 2.0% formaldehyde at 37.8°C. This is followed by a second formaldehyde wash of 1.8% for ten minutes. In between each two of these steps, the wool or hair is rolled out so as to remove as much of the previous wash water as possible. The fifth step is a rinse in a 0.25% formaldehyde solution at 37.8°C. Following this the wool is pressed out and dried in hot air at 110°C, the temperature dropping rapidly so that the wool will not be scorched. After the material is dried, it is blown into baling presses.

Annex 9

IMPORTATION OF ANIMAL BY-PRODUCTS

Requirements for the United Kingdom (Ministry of Agriculture and Fisheries)

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 arsenicals added, 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 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 cm^2; 1.3 atmospheres) for fifteen minutes, or

(*c*) treatment of the bones, after they are broken, with the vapour of benzine boiling between 95°C and 115°C 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 re-infection 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 (2) to (5) of the above-mentioned conditions.

Requirements for the United States of America (Bureau of Animal Industry, Department of Agriculture)

Hides and skins

For unrestricted entry any one of the following conditions can be met:

(*a*) They must originate in and be shipped directly from a country not declared by the Secretary of Agriculture to have foot-and-mouth disease and rinderpest.

(*b*) Hard-dried hides or skins.

(*c*) Hides and skins from animals slaughtered under national government inspection in a country and in an abattoir approved by the US Secretary of Agriculture. The declaration accompanying the hides and skins must specify that they were obtained from animals found free from anthrax, foot-and-mouth disease, and rinderpest.

(*d*) Hides and skins pickled in a solution of salt containing mineral acid and packed in barrels, casks, or tight cases while still wet with such solutions.

(*e*) Hides and skins subjected to the liming process sufficiently to have become dehaired and ready for immediate manufacture into products ordinarily made from raw hide.

Restricted entry is allowed for hides and skins subject to regulations of the Bureau of Animal Industry governing disinfection and transportation of such material.

Wool, hair, and bristles

No bloodstained material allowed entry.

Unrestricted entry allowed under any one of the following conditions:

(*a*) Same as (*a*) in preceding section.

(*b*) Wool or hair clipped from live animals, or pulled wool or hair, if reasonably free from animal manure in the form of dung locks or otherwise.

(*c*) Same as (*c*) in preceding section.

(*d*) Wool, hair, or bristles which have been scoured, thoroughly washed, or dyed.

Restricted entry is allowed for wool, hair, and bristles subject to regulations of the Bureau of Animal Industry governing disinfection and transportation of such material.

Annex 10

SYSTEM FOR MASS TREATMENT OF DOGS FOR ECHINOCOCCOSIS

A programme providing for the free anti-echinococcal treatment of all dogs within specified areas was inaugurated in Patagonia, Argentina, in 1948. Since that time the work has been carried on rather extensively in several other regions of that Republic and has also been practised in southern Brazil. The methods [1] used in these campaigns may well serve as a guide for similar activity in other parts of the world where canine echinococcosis is enzootic.

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 excites 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

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[1] Mendy, R. M. (1948) *Arch. int. Hidatidosis*, **8**, 713

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 four hours.

After the four hours have elapsed, the dogs are bathed or dipped in portable tubs containing 5% creolin solution.

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 four-hour 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.