THE
JOURNAL OF
COMPARATIVE PATHOLOGY
AND
THERAPEUTICS.

VOL. XII.—No. 3. SEPTEMBER 30, 1899. PRICE 2s. 6d.

THE MEASURES TO BE TAKEN AGAINST
TUBERCULOSIS OF THE DOMESTICATED ANIMALS.¹

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IT is necessary to combat tuberculosis of the domesticated animals, (1) on account of the danger to which human beings are exposed by the use of the milk and flesh of tuberculous animals, and through the tubercle bacilli which are discharged from the bodies of animals during life, and (2) on account of the notable economic loss which the disease occasions.

Inasmuch as the methods of averting the danger arising under the first of these heads is considered in another section of the Congress, I shall confine myself to a consideration of tuberculosis as a purely animal disease.

The disease is more prevalent among cattle than among any of the other domestic animals, and cattle are much more frequently the cause of direct or indirect infection of other species of animals than human beings are. Bovine tuberculosis will therefore here be considered in the first place.

Tuberculosis is spread solely by infection, that is to say, by the taking in of tubercle bacilli which have come from another individual, which may be either a human being or one of the lower animals.

The combating of tuberculosis must therefore aim at hindering the taking in of the bacilli. These bacilli may obtain access to the body either (*a*) during intra-uterine or (*b*) extra-uterine life.

¹ Translation of a paper contributed to the Proceedings of the Seventh International Veterinary Congress.

Fœtal infection plays a somewhat unimportant rôle, though it is true that congenital tuberculosis is by no means so seldom as was at one time supposed (on the ground of the statistics furnished by the large slaughter-houses). I have myself examined over one hundred cases of congenital tuberculosis, some of them being in the unborn fœtus and the others in the newly-born calf. But even in districts in which the disease is rather prevalent the proportion of cases of congenital tuberculosis scarcely exceeds 0·33 per cent. of the slaughtered calves.¹

That this should be so is easily understood when one reflects that tubercle bacilli can pass from the mother to the fœtus only when they have developed in the maternal placenta, or when they have at a given moment circulated in the blood of the mother, that is to say, when the mother has suffered from generalised tuberculosis. In the great majority of tuberculous cows the disease occurs only in a local form, and a placental infection of the calf then cannot occur.

A germinative infection implies corresponding conditions. Here again there must be tuberculosis of the ovary or of the sexual organs of the male, or the presence of tubercle bacilli in the blood of one of the parents.

These theoretical considerations are in correspondence not only with the results of the *post-mortem* examination of young calves, but also with the fact demonstrated by me and other observers, that the proportion of young calves which react to tuberculin is much smaller than that of yearlings and adult animals.

In the following table I have arranged, according to their age, the animals which I have tested with tuberculin in Denmark since 1893:—

<i>Calves up to six months old.</i>	Total.	Percentage reacting
From October 1893 to October 1895 . . .	7630	15·5
From May 1896 to May 1898 . . .	24,267	10·6
<i>Young Cattle from six to eighteen months old.</i>		
From October 1893 to October 1895 . . .	11,313	29·4
From May 1896 to May 1898 . . .	36,920	19·0
<i>Young Cattle from one and a half years to two and a half years old.</i>		
From October 1893 to October 1895 . . .	8921	40·5
From May 1896 to May 1898 . . .	22,425	25·6
<i>Adult Animals.</i>		
From October 1893 to October 1895 . . .	25,439	49·3
From May 1896 to May 1898 . . .	67,263	32·8

Tuberculosis is, therefore, in most cases not a congenital disease, but one acquired during extra-uterine life.

Veterinary-Inspector Knudsen, of Aarhus, Jutland, in 1898 found 23 cases (0·39 per cent.) of congenital tuberculosis in 5941 calves killed in the local slaughter-house, and 29 cases (0·37 per cent.) in 7789 calves killed elsewhere and examined at the control station. In Kiel, however, Klepp found cases of congenital tuberculosis somewhat more frequently. In the first five months of the year 1896 he found 26 cases (0·64 per cent.) of congenital tuberculosis in 4068 new-born calves killed in the local slaughter-house, and in October he found 10 (1·18 per cent.) out of 847 calves killed during that month.

That tuberculosis is relatively seldom present in newly born animals is admitted by most authorities. In former times, however, a great importance was attributed to inherited predisposition. I am far from denying that the resistance offered to invasion by the tubercle bacillus (as in the case of other pathogenic organisms) varies with the individual, and I think it in no way improbable that these varying powers of resistance, just like other properties of the tissues, may be inherited.

In my opinion, however, it ought to be recognised (1) that in all probability the smaller or greater tendency to tuberculosis is evinced much more by a greater or smaller power of localising the disease than by a disposition which hinders the penetration of the germs, and (2) that actually we know very little about different degrees of inherited predisposition in cattle. Among cattle there scarcely exists such a degree of immunity against tuberculosis as will render the entrance of tubercle bacilli into the body impossible, or prevent the development of a tuberculous nodule in an infected animal. It is certain that every animal of the bovine species may become tuberculous. Regarding predisposition to the disease the reaction to tuberculin gives us no indication, for it may well happen that a slightly susceptible animal reacts because it has been accidentally exposed to an intensive infection, while another, perhaps markedly susceptible, does not react simply because it has never been exposed to any risk of infection.

In large herds containing animals of different strains I have never been able to recognise that the disease took a more malignant course in one strain than in another.

So long as a special predisposition to the disease is not recognisable, we ought, in my opinion, to attach no special importance to the alleged inherited tendency in the prophylactic measures which we take against the plague, and, in any case, it is absolutely unjustifiable to conclude that an ox or a cow is specially predisposed because it has reacted to the tuberculin test. So long as the parents are clinically sound, and the disease in them is betrayed only by a reaction to tuberculin, we need not fear on the part of the calf either a congenital tuberculosis or a special susceptibility to the disease. The calves are born healthy, and they remain healthy as long as they are protected from infection.

On the ground of the foregoing considerations I cannot attach anything like so great an importance to freedom from reaction on the part of bulls used for breeding purposes as is usually ascribed to it. It is obvious that such freedom from reaction is a valuable quality, and one which deserves to be taken into consideration, especially in the case of a high-priced imported bull. A bull that is to be used to serve cows that are free from tuberculosis ought obviously to be himself quite healthy, but one ought not to believe that a great step in the combating of tuberculosis has been taken by the exclusive use of bulls that do not react to tuberculin. As a rule, even such a "clean" bull will react half a year or a whole year after his introduction into an infected herd, and where does the advantage remain then? When one breeds from reacting cows all that is required of the bull is that he shall be clinically sound, for, as a matter of fact, the immense majority of such bulls will furnish

healthy semen. In judging bulls for the awarding of a premium it is decidedly important to allow something for freedom from reaction (to give several "points" for it). In view, however, of the present great prevalence of tuberculosis in most civilised countries, it is, I think, a mistaken policy to completely exclude from awards for a premium bulls that have reacted. It is possible that one might thereby exclude bulls which would have contributed to the improvement of the breed. Naturally I would desire that it should not be awarded to a bull that has reacted, as this would act in the direction of combating the disease. In this matter, however, breeding interests must be taken into consideration.

A much greater rôle is undoubtedly played by the susceptibility acquired in consequence of weakness, pampering, and previous attacks of disease, etc., than by inherited predisposition, and therefore, with a view to prevention, an appropriate diet and the bringing up of the calf in such a way as to give it a hardy constitution are of great importance.

During extra-uterine life infection may take place in several different ways. Among the rarer of these ways are infection through wounds, copulation, and the entrance of bacilli into the teat canal. Most frequently the bacilli are taken in through the digestive or respiratory organs. As is well known, there has been much dispute as to which of these is the commoner way, and it is still maintained by many people that, in the case of cattle, the bacilli are mainly taken in through the digestive organs. The result of *post-mortem* examination, however, is in contradiction with this view, since in many cases the tuberculous lesions are found only in the bronchial glands or in the lungs or in both of these. The interest in this question, however, is really more theoretical than practical.

From a practical point of view it is more useful to distinguish between :—

1. Infection through articles of diet which contain tubercle bacilli, and

2. Infection through cohabitation.

1. Under this head, in the case of cattle, one has to do almost exclusively with the admixture of tubercle bacilli with milk or milk products. In the infection of calves with tuberculosis, tuberculous milk plays a very important part. As a matter of fact, in the case of reacting calves one generally finds the lesions exclusively or mainly at the places where bacilli introduced with the food first penetrate, viz., in the retropharyngeal and mesenteric glands. This fact, however, is so well known and so easy to recognise that I need not discuss it at length, but I would like to call attention to the great danger attaching to the use of the milk furnished by a tuberculous udder. It ought further to be observed that without any clinically recognisable disease of the udder tubercle bacilli are sometimes excreted through the mammary glands of cows suffering from generalised tuberculosis. Perhaps more importance attaches to the fact to which A. Eber has called attention, namely, that the bacilli, which are certainly often present in the faeces of tuberculous cows, may very well be a source of infection of milk which is by itself quite normal. This explains how it is that even in herds in which

there is no case of udder tuberculosis, and perhaps even none of very advanced general tuberculosis, the calves, nevertheless, appear to become infected by the raw milk. That tuberculosis is so easily spread by public creameries is also ascribable to this fact.

The danger attaching to feeding with milk can be obviated by warming the milk to 85° C. In Denmark we have adopted this measure of prevention with the most excellent results. However, as these precautions are not yet employed daily and with the necessary care in the public creameries, one must in the meantime take special means of combating the most dangerous source of infection, namely, tuberculosis of the udder. In this there lies also a very great danger for human beings, especially because the milk secreted by the diseased quarter at the outset, and often for a considerable period after infection (a month or more), retains an almost normal appearance, and is thus undoubtedly often consumed. In the later stages, when the milk has become watery and flocculent, and is no longer milked into the pail, the milking of it on to the floor may contribute greatly to the infection of the cow-shed. I therefore consider it a most important step in advance that in Denmark, under the regulation of the 26th March, 1898, all cows in which tuberculosis of the udder is officially diagnosed are immediately slaughtered with compensation.

Pigs, carnivora, and domestic fowls may be infected with tuberculous milk, with tuberculous organs, or with the flesh of highly tuberculous animals. To combat this danger, diseased organs must be destroyed, and the flesh must be cooked.

2. In the case of the older calves and adult cattle the milk plays no part in infection. Here infection is brought about mainly by the cohabitation of tuberculous with sound animals, that is to say, by the accidental entrance of tubercle bacilli voided from some diseased animal. It is quite obvious that the danger of infection will be immeasurably greater in-doors than in the fields. It is certain, however, that even in the open air infection is not excluded, especially when the cattle are free to run about and lick one another, and when several animals are allowed to drink from the same vessel. When, as is the rule in Denmark, the cattle are tethered, and a separate drinking vessel is kept for each cow or for each pair of cows, the danger is much less than when the animals are kept together in-doors. The worse ventilated and the darker the stall, and the less the attention paid to cleanliness, the greater the danger. The danger is increased by keeping the cows in rows with their heads towards one another, by watering them at a common drinking trough, and also by the presence of old woodwork, etc., which is difficult to disinfect. But even the most approved construction of the cowshed, and the most careful attention to cleanliness will not completely obviate the danger. In enclosed buildings the bacilli voided from the animals accumulate, and in the course of months or years almost all the healthy animals introduced fall victims to infection. In such circumstances the bacilli may be inhaled in the dry or moist state, or they may be taken in with food or water. That this is so is proved by the observation that in large herds in which tuberculosis has been prevalent for years the great majority of the animals (70 to 80 or often up to 100 per cent.) react to the tuberculin test in spite of their healthy appearance,

whereas, on the other hand, one can often observe that in herds in which the disease was previously unknown only a single recently introduced animal, and possibly also its neighbours, will react. The peculiar fact that in badly affected herds all the adult cattle and most of the heifers and young bulls react, while the calves of a few months old in the same premises do not react, indicates that the danger of infection increases with the duration of the cohabitation. When the calves are separated from the other cattle and placed in special premises one often finds that relatively few of them become the subjects of tuberculosis (and then almost exclusively alimentary tuberculosis), even when the disease is very prevalent among the adult cattle.

It is thus firmly established that tuberculosis is mainly spread by the cohabitation of healthy and diseased animals in the cowshed. Herein lies the great difficulty of dealing with tuberculosis under our climatic conditions, which necessitate the cattle being kept in-doors for a large part of the year.

The influence of cohabitation on infection is very distinctly shown by the favourable and also by the unfavourable results of attempts to combat the disease by effecting a separation between the healthy animals and those that react. Very often farmers are not inclined to go to great expense in effecting a complete separation. They think that it would be quite sufficient to put the sound and the reacting animals to opposite sides of the building, or to prevent promiscuous contact by an incomplete partition. In such cases the result is almost always unfavourable when the test is repeated at the end of the year, whereas, on the other hand, when the separation is carefully carried out the result is as a rule satisfactory, and, indeed, almost always proportional to the care that has been taken to prevent infection by intermediary bearers. The separation is best effected by keeping the sound and the reacting animals on different farms; the next best plan is to keep them in different buildings on the same farm, and a less good arrangement is to keep them in opposite ends of a building divided into two by a close wall. This last plan is least satisfactory when the dividing wall has a door in it. I have, however, now and again seen good results obtained under such conditions, especially when the door was opened as seldom as possible.

It thus appears that the main thing to aim at in combating tuberculosis of cattle is the prevention of infection by separating the sound from the diseased animals.

The first thing to do is to find out which animals are diseased. Whereas in most cases this was almost impossible before the discovery of tuberculin, the recognition of tuberculosis in the living animal has to-day been made much easier, but, nevertheless, not in all cases.

When a herd is tested with tuberculin for the first time the indications afforded are in most cases pretty clear. The animals which give a typical reaction are all, or almost all, tuberculous, although the reaction gives no indication regarding the extent of the disease. The animals in which no reaction occurs are at least to the extent of 90 per cent. free from tuberculosis.

It is a known fact that some animals at a very advanced stage of tuberculosis will not react, but as a rule these cases can be detected

by a careful clinical examination (which ought to include an exploration per rectum). If the clinical examination of such animals is omitted they may be left in contact with the sound animals, with the result of defeating the measures put into force. Of much more frequent occurrence are cases in which a few old caseous and calcified tubercles, generally in some one of the lymphatic glands, are found at the *post-mortem* examination of an animal that has not reacted. However, the introduction of such an animal among healthy animals will very seldom have any bad effect, because as a rule in these cases the lesions are at a retrogressive stage and do not subsequently become active.

Hence, it appears that in the rational attempt to combat tuberculosis by separating the diseased herd into two divisions, tuberculin, in spite of its defects, is, when carefully used, as a rule capable of doing all that is required of it in practice.

Tuberculin, however, has still another defect besides those mentioned. First among these is the fact that through repeated inoculation animals acquire a tolerance for tuberculin. As is well known, it very often happens that a cow which has reacted will not react again when re-tested after a short interval. It is true that this is comparatively seldom observed after the first reaction, but by repeating the injection several times one can, as a rule, bring about a temporary insusceptibility. Unfortunately, this makes it possible to practice dishonesty in dealing, and places great difficulty in the way of acquiring a sound herd by purchase.

It would, therefore, be desirable to make it obligatory to mark all reacting cattle, but this would be difficult to carry out so long as the law does not compel the examination of all cattle. In the meantime, a warranty ought, as a rule, to be obtained from the seller, and the introduction of cattle of unknown origin into a sound herd ought to be absolutely prohibited.

The fact to which I have called attention in previous publications,¹ namely, that even when the tuberculin test is first repeated after the lapse of a year a considerable number of animals that reacted on the first occasion fail to do so on the second, is much more difficult to understand than the immunity acquired by repeated tests at short intervals. In many of these cases I found at the *post-mortem* examination comparatively small lesions, which, although not healed, were stationary and obsolete. In other cases, however, extensive disease was found in such animals. It is necessary to know this, so as to warn the owners in the strongest possible way against regarding such animals as cured. Animals which on the ground of a typical reaction have been placed in the reacting division ought never again to be admitted amongst sound animals.

The diagnostic value of tuberculin is further diminished by the fact that cattle which have been removed from their ordinary surroundings, have recently made a journey, or been exposed in a market, etc., generally react very slightly or not at all.²

It appears as if mental excitement diminished the susceptibility of the heat centre for the substances developed in the

¹ "Deutsche Zeitschrift für Tiermedizin," Vol. XXII., pp. 13-14.

² M'Fadyean has specially insisted upon this fact. Report of the Royal Commission, 1898, Part I., p. 3.

tuberculous tissue under the action of the tuberculin. It is important to know this, as it explains many of the cases of failure with the tuberculin test. It often happens that cattle which are sold by a dealer with a veterinary certificate of non-reaction react a short time afterwards with the new owner, and this is well calculated to shake confidence in the tuberculin test. Such cases do not prove either carelessness on the part of the veterinary surgeon or dishonesty on the part of the dealer (through his having induced immunity). The veterinary certificate to the effect that there was no reaction is explainable by the fact that the animal when tested was under the action of one of the before-mentioned influences. It is therefore necessary in testing cattle that have changed hands to give them a few day's rest, and to use a larger dose than usual, as otherwise the temperature may not rise to the usual height.

The before-mentioned defects certainly diminish the value of tuberculin as a diagnostic agent, but they do not make it worthless. In spite of them, tuberculin remains a most valuable and indispensable assistance in combating bovine tuberculosis, but the use of it demands care.

From the foregoing considerations regarding the way in which infection takes place one sees immediately what measures require to be taken when a cattle-owner desires to eliminate the disease from his herd. The progeny of cows and bulls suffering from advanced tuberculosis must not be reared, but all others may be kept, provided they are immediately removed from the infected building and their infection through the diet is prevented by giving them only milk which has been boiled or heated to 85° C.¹

When healthy animals are kept permanently separated from the diseased, and care is taken to prevent infection through the agency of the attendant or the utensils, they undoubtedly remain healthy. In favourable circumstances it would even be possible for a cattle owner to free his herd from tuberculosis in this way without having resort to the tuberculin test. It is obvious, however, that it requires a long period to succeed in this way, and that it also demands extensive accommodation and determination on the part of the owner.

As the diagnostic importance of tuberculin became known, one soon saw how it might be used in order to shorten the process. I have recommended that the owner should, with this object, have his whole stock tested, and immediately thereafter effect an entire separation between the reacting and the non-reacting animals; further, that he should have the animals found to be healthy retested every year, or, better still, every half year, in order to be able to remove as quickly as possible any animals which in the interval may have contracted the disease in spite of their isolation. I believed that in this way one would be able to attain the object in view, even when the facilities for separation were not altogether perfect. As is well known, I have carried out this plan since 1892 on one farm (Thurebylille), and since 1893 it has been put in force on many farms in Denmark. In many other countries also resort has been had to this or some quite similar plan, and, so far as I am aware, corresponding results have generally been attained. Regarding the improvements effected in Denmark, I

¹ Calves may be fed in this way after the second day, but during the first day they must be given the colostrous milk. The danger of infection thus arising is very slight.

have already made a short report to the International Veterinary Congress which met in Berne in 1895.¹

I have also described these results at length to the Congress on Tuberculosis held in Paris in 1898. In the report to that Congress, to which I may here refer, there is attached an appendix setting forth the results attained on a series of larger and smaller farms.

Taken as a whole, the plan is not only theoretically correct (rational) but also practicable. It is true, as I have already mentioned, that the execution of it is attended with many difficulties. In particular, the separation of the stock into two divisions at the same farm demands a great deal of trouble, and it cannot be denied that the before-mentioned defects of tuberculin not seldom also create difficulties.

If it is now asked whether or not, as a result of my somewhat extensive experience, I have found any points which require special attention in order to obtain favourable results, I would, in addition to the remarks already made on this head (careful carrying out of the separation, thorough disinfection of the building set apart for the sound section, correct interpretation of the results of the tuberculin test), call special attention to the necessity of watching closely the reacting division. That is to say, should any animal in this division of the herd develop a form of the disease attended with special danger of infection—one associated with a very abundant discharge of bacilli, such as tuberculosis of the udder, uterus, or intestine, or an ulcerating tuberculosis of the lung—it must be slaughtered as quickly as possible. Such an animal may daily void an enormous number of tubercle bacilli from its body, and thus give occasion for spread of the disease to the healthy section.

When one has to do with a large herd in which tuberculosis has been prevalent for many years, one may as a rule omit the testing of the adult cattle. In such a case the majority of these will react even when they appear to be quite sound.

Experience has taught me that even among the few that do not react a somewhat large proportion may not be free from tuberculosis. Cattle which have lived for several years constantly exposed to risk of infection from their neighbours as a rule contain bacilli, and harbour in their bodies some old, small tubercles, mostly in the bronchial or mediastinal glands. To this category, indeed, belong most of the individuals which, as mentioned above, do not react although they are tuberculous. Although such animals do not generally become dangerous, a further development of the disease in them is not excluded, and therefore it is best not to admit them to the healthy division. In large tuberculous herds it is consequently better to include in the sound section only the calves and the non-reacting young cattle. In this way the owner is spared the pain of seeing that the majority of his cattle are not free from tuberculosis. For herds that are only slightly affected I always recommend that the whole of the animals should be tested.

The method here described, imperfect as it is, furnishes a means by which the owner, with some trouble it is true, but without great economic loss, may free his stock from tuberculosis.

¹ A rather fuller report on the same subject appeared in the "Deutsche Zeitschrift für Tiermedizin," Vol. XXII.

What has been said above implies only a voluntary attempt to combat tuberculosis, not a legislative control as in the case of other infectious diseases of animals. In my opinion, the State can and must assist voluntary efforts by supplying the tuberculin gratis or at a low price, and by paying the veterinary surgeons for carrying out the examinations, as is done in Denmark, Norway, Sweden, and several other countries.¹

One may now reasonably ask whether the State ought not to directly undertake the measures necessary to combat bovine tuberculosis, and whether the disease (in most countries the most prevalent of all) should not be dealt with like other infectious maladies.

In the first place, one must know whether it is possible to stop the sources of infection.

It has often been asserted that cattle are frequently affected from human beings; indeed, at the Berne Congress Professor Guillebeau asserted that the ox is mainly infected by sputum from phthisical human beings (General Report, p. 681). If this were correct it would be useless to think of combating bovine tuberculosis in the meantime. I am convinced, however, that it is entirely erroneous. Infection of cattle by bacilli voided from the human body is undoubtedly possible, and one should therefore not allow consumptive persons to act as attendants upon cattle. At the same time, there are very few observations on record pointing to this method of infection.

On the other hand, when tuberculosis first breaks out in a previously sound stock it can almost always be ascertained that the disease was introduced by an affected animal, or through the feeding of calves with tuberculous milk sent out from some public creamery. Against the view that bovine tuberculosis has frequently a human origin, there stands also the fact that a great number of stocks entirely free from tuberculosis are to be found in countries in which tuberculosis is very prevalent among human beings. In countries in which tuberculosis of cattle was originally almost unknown, but in which it has steadily become more prevalent during the course of the present century, it can almost always be ascertained (as I have done in the case of Denmark) that the disease was introduced with cattle from countries in which tuberculosis was of common occurrence.

Just as in the case of human tuberculosis the chief source of infection is man himself, so also bovine tuberculosis comes mainly from the ox.

The recent experimental investigations of Theobald Smith of Boston (*Journal of Experimental Medicine*, Vol. III., 1898) have shown that the ox is much more easily and more severely infected with cultures obtained from bovine tuberculosis than with those obtained from lesions of the human subject. The possibility of

¹ It is obvious that this assistance should be made conditional on the owner undertaking to keep the healthy animals and the reacting or untested animals in separate buildings, for otherwise it is useless to carry out the test. It is also very much to be desired that the reacting animals should be branded. This is the rule in Norway, where it is also ordained that such animals shall be sold for slaughter only. This could be hardly carried out without special compensation in countries where the disease is very prevalent, for otherwise the owner who made a rational attempt to deal with the disease would be placed in a less favourable position than those who do nothing at all, but simply sell their cattle. Moreover, I think that the regulation which forbids the sale of reacting cattle, save for slaughter, is too stringent. It would, in my opinion, suffice to require the animals to be marked, for reacting animals may be profitably kept for years, and their introduction into an already affected stock entails scarcely any aggravation of the state of affairs. It is sufficient that the purchaser should know what he is buying.

infection from tuberculous human beings, therefore, need not frighten us from attempting to combat bovine tuberculosis.

The idea of combating the disease is not at all utopian. Bovine tuberculosis is not, as was formerly supposed, an ubiquitous disease following on the forced development of the cow as a milking animal, for many stocks which are quite free from tuberculosis contain most excellent milkers. The disease is introduced with infected animals or with infected milk. It is possible to prevent it, and it is also possible to get rid of it. The circumstances, however, which make the task of stamping out bovine tuberculosis so very difficult are:— (1) The great prevalence of the disease; (2) the fact that in most cases the disease occurs in a form which entails only slight economic loss, and which apparently would not justify the slaughter of all tuberculous cattle; (3) the before-mentioned relative unreliability of tuberculin as a diagnostic agent.

That in most civilised countries tuberculosis is widely prevalent among cattle is a fact which I need not discuss at any great length.¹ It is true that in some countries, such as Norway and Finland and some parts of France, the native uncrossed breeds are still comparatively little affected. In most countries, however, careful examination in the slaughter-houses and the application of the tuberculin test show that a very large proportion of the adult cattle are affected with tuberculosis.²

With regard to the second point, it is well known that at the *post-mortem* examination of reacting cattle as a rule only unimportant lesions, entailing no economic loss, are to be found. I have had the opportunity to trace the history of such reacting animals for many years, and in several cases I ascertained that in cattle which had reacted five or six years previously the disease had remained quite stationary and very limited in extent.

The observations made in slaughter-houses have also shown that in the immense majority of tuberculous cattle the lesions are so circumscribed that under the now generally recognised rules of meat inspection their flesh may safely be passed for human food.³

One need not refrain from carrying out the slaughter of reacting cattle because the loss resulting therefrom would be comparatively slight. But it is precisely the knowledge of the relative harmlessness of the most common forms of bovine tuberculosis which will prevent Governments from compelling the slaughter of all tuberculous animals. In this connection much may be learned from the extensive experiments with regard to the stamping out of tuberculosis which in recent years were made in Massachusetts and in Belgium.

The task which the authorities set before them in Massachusetts (1894) was to slaughter as quickly as possible all tuberculous cattle. The inspectors in the various districts had to examine the whole of

¹ In my report to the Congress on Tuberculosis which met in Paris I have given figures relating to a number of different countries. I may here refer readers to that report.

² The fact that in Denmark tuberculin was used earlier and on a larger scale than in other countries, and the publication of the information thereby obtained, have given currency to the erroneous belief that tuberculosis is therefore specially prevalent here. In face of the statistics now available from other countries it does not appear as if the proportion of 28·8 per cent. found by me were uncommonly great.

³ Siedamgrotzky has called attention to the fact that in Germany at the outside only from 2 to 3 per cent. of the tuberculous animals are totally condemned, while from 5 to 6 per cent. are sent to the Freibank, and about 92 per cent. are passed as quite wholesome (*Archiv f. Thierheilkunde*, Vol. XXIV, p. 67).

the cattle at least twice a year. Every animal suspected of tuberculosis was tested with tuberculin, and in the case of reaction the animal was killed and compensation was awarded (half of the value). When it had become evident that this procedure would never suffice to stamp out the disease, the systematic testing with tuberculin of all the cattle in three small districts was tried, but that also had soon to be abandoned, as the cost was too great. In addition, all cattle imported from other States had to be tested with tuberculin, and those that reacted were sent back.

In the following year the regulations with regard to the testing of suspected cattle were altered so as to give greater influence in the matter to the State Veterinary Commission. An attempt was also made to incite the owners to deal with tuberculosis in a rational manner by isolation and disinfection, but, as it appears, without any great result.

Although, as shown by the report made by Dr Parker to the Veterinary Congress in Nashville in 1897, there can be no doubt that the cases of malignant (generalised) tuberculosis were reduced in number (from 32·6 to 3·6 per cent. of the slaughtered animals), the efforts must be considered to have failed, for the Veterinary Commission in the report which it issued in January 1898 admitted that in spite of the very great expenditure (latterly 250,000 dollars yearly), no appreciable reduction in the prevalence of bovine tuberculosis was recognisable.

In consequence of this, in the year 1898 the Government refused to vote any more money to the Veterinary Commission. This was truly a sad result, and in a large measure it was brought about by the high rate of compensation paid for the slaughtered animals, the flesh of which was condemned even when the disease was of very slight extent. In any case, the Massachusetts experiments show the great difficulties which stand in the way of combating bovine tuberculosis by means of legislative enactments. The same is shown also by the experience of Belgium.¹ The law which was introduced there in January 1896 was essentially as follows:—

1. Compulsory notification on the part of the veterinary surgeon and the owner in every case of tuberculosis discovered either in the living or slaughtered animal (or after natural death).
2. Veterinary examination of the stock from which the tuberculous animal came.
3. Slaughter of the clinically tuberculous animals and also of those suspected in consequence of a reaction to tuberculin, the owner at the same time to receive compensation.
4. Disinfection of the building.
5. Prohibition of the sale of suspected animals (that is to say those which had been in cohabitation with a tuberculous animal) save for slaughter. The only animals exempted from this were those that did not react.²
6. The cattle of every owner to be tested with tuberculin at the cost of the State, on his undertaking to effect a separation between the sound and the reacting animals. In herds in which no case of

¹ It was a lecture given by Nocard at the International Agricultural Congress in Brussels which gave the impulse to the stamping out of tuberculosis in Belgium.

² The owner was thus indirectly compelled to resort to the tuberculin test.

tuberculosis had previously been detected the owner himself had to bear the cost of the tuberculin test. The sound division, into which only animals that did not react to tuberculin could be introduced, had to be re-tested annually.

7. The milk of reacting animals could be sold only in the cooked condition. The animals themselves had to be slaughtered within a year. Private persons were forbidden to test animals with tuberculin. Save in the case of animals intended for slaughter, all imported cattle had to undergo the tuberculin test while quarantined at the frontier.

These regulations were in the main rational, but No. 7, which compelled the slaughter of reacting cattle even when they appeared to be clinically quite healthy, went too far.

The experience gained during the first year and a half of these operations showed that it was necessary to make some important changes in them. In introducing the new regulation on the 10th August 1897, the Minister said:

"The large number of tests made with tuberculin in the year 1896 have shown that tuberculosis is so prevalent¹ in Belgium that the slaughter of all affected animals within a relatively short period would, without any real necessity, create the most serious inconvenience to many agriculturists. On the other hand, the slaughter of animals that had been submitted to the tuberculin test has shown that in the immense majority of cases they are only slightly attacked with tuberculosis, and are not capable of propagating the disease. In these circumstances it hardly appears necessary to compel the sacrifice of such animals within a definite period. In almost all cases it would suffice to isolate them, without preventing the owner from making full use of them as long as they do not exhibit manifest symptoms of the disease. In view of these considerations I believe I am justified in making various modifications which will have the effect of sensibly diminishing the rigour of the law of 30th October 1895."

The alterations thus effected comprise some that are very useful, especially that which permits the owner to keep his reacting animals so long as they do not show any clinical symptoms. However, he receives no compensation when they are slaughtered unless this has been carried out within three years. It is also right not to insist that the milk of such animals should be boiled. On the other hand, the new regulation ordains that the calves of reacting cows must be immediately separated, and after the second day fed with sterilised milk. Less useful appear the limiting of the duty of reporting to veterinary surgeons, and the official veterinary inspection of herds which are kept for breeding purposes.

The regulations also appear to have been weakened in so far as animals suspected of infection, that is to say, those that have been in cohabitation with tuberculous cattle, may be sold for other purposes than slaughter so long as they are not clinically diseased. This practically amounts to an abandonment of the attempt to stamp out the disease.

On the other hand, the measures for dealing with the apparently diseased animals are pursued with the same energy as before. The "clinically diseased" animals must be slaughtered within eight days, and the "clinically suspected" must be separated, unless the owner prefers to have them tested and killed at his own expense provided

¹ In all 2905 herds, including 19,004 cattle, were tested, and of these 48·8 per cent. reacted.

they react. The compensation given for breeding cows and for pregnant heifers is increased, inasmuch as it is to be based not on their value after slaughter but their value according to the purpose for which they were used. This, however, applies only to the first occasion on which the disease is detected in a herd. In the case of animals slaughtered in consequence of their having reacted to tuberculin the compensation is based on their value after slaughter.

As in the former regulation, it is still forbidden to sell for other purposes than slaughter diseased or suspected (this including also reacting) animals.

The regulations with regard to the isolation of the sound division of a herd that has been submitted to the tuberculin test are needlessly stringent, seeing that it is now permitted to introduce new animals into the sound division without their having been submitted to the tuberculin test provided they exhibit no clinical symptoms.

The attempt made in Belgium to stamp out tuberculosis is very interesting. The method was more rational than the one employed in Massachusetts, where, besides, there was no well-organised veterinary service, a large number of the inspectors having had no veterinary training. Furthermore, in Belgium general meat inspection has been in force for years. Belgium is also a rich country, where parliament is prepared to spend large sums in the agricultural interests. In the year 1897 alone, more than one million francs was paid in compensation for slaughtered tuberculous cattle. Nevertheless, the object which was originally entertained of stamping out bovine tuberculosis has already been abandoned. Herr Stubbe, the Chief Inspector in Belgium, at the Paris Congress last year expressed himself as follows:—

“It would be better, we think, to proceed more slowly but surely. There is no occasion to ‘rush’ matters when one has in view an object requiring some time for its attainment. The extermination of tuberculosis requires time and money.”

It is to be regretted that under the new law the very useful regulation which indirectly compelled the owner to resort to the tuberculin test when cases of the disease occurred in his herd is no longer enforced, and it will therefore be less frequently carried out than formerly. “The intelligent owners, however, have recourse to it.” Unfortunately, the intelligent owners are always in the minority.

Up to the present time in Belgium no legal enactments are in force to prevent the spread of tuberculosis from public creameries, but this is a defect which probably can be easily remedied.

I do not doubt that Belgium will gradually be able to materially diminish the prevalence of bovine tuberculosis, provided sufficient money can be found to admit of the slaughter of all clinically diseased, clinically suspected, and reacting animals. It is just as certain that it will not succeed in stamping out bovine tuberculosis so long as the reacting animals are not separated from the healthy ones. Unfortunately, even this regulation will not always suffice, precisely because one must reckon with the relative uncertainty of the tuberculin test. The most rational procedure would be to treat bovine tuberculosis in the same way as contagious pleuro-pneumonia of cattle, that is to say, to compel the slaughter of all animals

suspected of infection, but it is obvious that in the meantime such a drastic method is not to be thought of; it might be advisable on the first introduction of the disease into a country previously free from it, but even in such a case it would be a mistake to altogether overlook tuberculosis of the human subject as a source of infection.

At the present time the stamping out of bovine tuberculosis is not to be thought of. For an indefinite time to come efforts must be limited to an attempt to gradually repress the disease, to diminish its severity, and to reduce the danger for the human subject which it carries with it.

What are the appropriate means for attaining this object?

1. The first thing to be done is to disseminate correct views regarding the nature of tuberculosis, the methods of infection, and the importance of the tuberculin test.

Regarding all these points not only the farmers but all the inhabitants of the country ought to be instructed.¹

One must persevere in this direction for a long time to come, until correct information regarding the matter has been clearly brought home to the people. It must not be forgotten that professional opinions regarding tuberculosis of cattle have been greatly changed, especially during the last ten years, since the introduction of tuberculin, and one can therefore easily understand that farmers have difficulty in assimilating modern views. But without a correct understanding of the matter one cannot expect rapid success in the attempts to combat the disease.

2. The second tremendously important task is one affecting the owners of cattle. It is for them to gradually cleanse their herds from tuberculosis by preventing infection of the calves and all other as yet healthy cattle.

Already much may be done in this way where breeding is carried on. Without the voluntary co-operation of the owner it is impossible to do anything against the disease. The State, however, can assist the owner by supplying the tuberculin and the services of the veterinary surgeon free of cost.²

3. The third step is to immediately dispose of the badly diseased animals.

When diseased animals discharge large numbers of bacilli, as is the case in ulcerating tuberculosis of the lung and tuberculosis of the intestine, uterus, or udder, but not in *perlsucht* of the serous membranes, or in tuberculosis of the lymphatic glands, it is in the interest of the owner himself to quickly dispose of the animals, which constitute permanent centres of infection. Without compulsion, however, little can generally be attained in this direction, especially since the owner, in many cases, does not apprehend the real nature of the disease.

It is, therefore, necessary to ordain by law that the owner must notify all suspected cases—chronic diseases of the chest associated with emaciation, cases with vaginal discharge apparently not due to retained placenta, insidious udder disease accompanied by the formation of a hard swelling but without immediate alteration in the

¹ Such instruction ought also to embrace the hygienic construction of cowsheds, rules for disinfection, and the necessity for destroying diseased organs.

² In order not to impose too great a strain on the Exchequer, well-to-do owners might themselves defray the veterinary expenses.

character of the milk, and chronic diarrhœa, especially in combination with chest symptoms. As soon as the nature of the disease has been determined by the veterinary surgeon, the animal must be separated from the other cattle, and slaughtered within a short period. In cases of tuberculosis of the udder and uterus the diagnosis must always be based on the detection of tubercle bacilli in the secretion (which is best done in a central station). In cases of suspected tuberculosis of the lung the diagnosis might be fortified by the tuberculin test. In this connection it ought not to be forgotten that an animal with some non-tuberculous disease of the chest (determined by worm parasites for example) might react owing to the simultaneous presence of an unimportant tuberculous lesion in a lymphatic gland.

Where general meat inspection is carried out, the veterinary surgeon or meat inspector might be required to report, as Siedamgrotzky has recommended.¹ It would then be possible to ascertain the origin of animals found to be tuberculous on slaughter, and to subject the herds from which they came to veterinary inspection. All this of course would leave unaffected the obligation of the owner to report.

Subsequent veterinary re-examinations of infected herds (about once a quarter, as Siedamgrotzky has recommended) are undoubtedly valuable.

Although the necessity for prompt slaughter of badly tuberculous animals (especially those suffering from some form of the disease peculiarly liable to spread the infection)² is hardly denied by anyone, opinions with regard to the question of compensation are still divided. Most members of the profession are in favour of compensation. It is not unreasonable that it should be granted, and, indeed, to the full value in cases of errors in diagnosis. It may, however, be questioned whether in every case compensation ought to be given for badly tuberculous animals. It might be given in view of the present depressed state of agriculture, although in the majority of cases it is useful to the owner, rather than injurious, to quickly get rid of such animals. In no case ought the compensation to be high, for if the farmers were not constantly reminded that tuberculosis occasions some sensible loss they would cease to do anything. It is also important to notice that even low compensation would require very large sums, and it would therefore be difficult in most countries to find the necessary means. Perhaps the best way of solving the question would be to introduce a system of compulsory insurance.

Slaughter of the animals worst affected is a regulation necessary to check the spread of the disease, but it is not sufficient to stamp it out. Under all circumstances the owner ought to be encouraged to combat the disease voluntarily by the use of tuberculin, isolation, etc. Where it is found to be impossible to give compensation for all the loss sustained, it ought, at least, to be granted for the slaughter of clinically tuberculous animals belonging to farmers who have earnestly carried out the voluntary method of combating the disease. That

¹ "Archiv. f. Tierheilkunde," Vol. XXIV., p. 76.

² It would be quite rational to treat animals which discharge bacilli abundantly in a different way from those in which the tuberculous lesions do not stand in direct communication with the outer world. I admit, however, that it is scarcely possible to carry out such a distinction in practice, when legal definitions have to be taken into consideration.

would insure the separation of the sound from the diseased animals, and it would perhaps also pave the way for introducing a system of marking the reacting animals.

4. Tuberculosis of the udder, on account of the great danger of infection which it carries with it, demands special attention.

It is not only a serious source of dissemination of tuberculosis within the affected herd, but, through the agency of public creameries, it is also dangerous for other herds. Lastly, this is the form of the disease which specially endangers public health. In any case, therefore, this form of the disease must be combated by law, even if regulations against the other specially dangerous forms are in the meantime not enforced. It would, in fact, be inexcusable if everything possible were not done to prevent such an important article of diet as milk from being converted into a dangerous poison. And that the danger is great cannot be doubted, when one reflects that the milk furnished by a tuberculous udder retains its normal appearance for weeks, and is undoubtedly employed as long as that for human food. It will be a long time before we can insist that only boiled or adequately pasteurised milk shall be used.

It is true that tuberculosis of the udder most frequently occurs in cows which would on other accounts be classed as "clinically tuberculous," but that is not always the case, as it is also met with in apparently healthy well-nourished animals which are free from tuberculous lesions in other parts of the body. It is therefore advisable to insist upon the immediate slaughter of every animal affected with udder tuberculosis.¹

5. On account of the great risk of the disease being spread by public creameries, these ought to be forbidden by law to return the separated milk before it has been heated to 85° C.

The slaughter of animals affected with tuberculosis of the udder does not make this regulation superfluous, because even the milk from cows not affected with mammary tuberculosis may contain bacilli, probably often in consequence of particles of fæces mixed with it. When the creameries also offer to return the butter-milk they ought to be compelled to heat the cream before butter is made (as has been the case in Denmark since 1st June 1899). This has no injurious effect on the butter, but it deprives that of all risk of infection. Strictly speaking, the whey ought also to be heated to 85° C., but this may be omitted, since, in general, the whey is used only for feeding pigs. On account of the special danger attaching to the sediment obtained when the milk is "separated," steps should be taken to render this innocuous. Under the Danish law it has to be burned.

I hope that the Congress will recommend the above-mentioned points to the different Governments as being deserving of their consideration and support. It is true that the execution of them would not secure the complete eradication of bovine tuberculosis, but they would impose a gradual check on this formidable plague. Some decades hence it may be possible to take more energetic measures.

¹ The Danish regulation allows the owner a compensation of 25 per cent. of the value of the carcase when the latter is passed for food, and in other cases 75 per cent. In all cases the diagnosis is based on a microscopic examination of the milk, samples of which are sent to my laboratory by the veterinary surgeons.