



# TUBERCULOSIS IN ANIMALS AND MAN

*A Study in Comparative Pathology*

*by*

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To SALLY

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My book 'Bovine Tuberculosis' published in 1947, inevitably provided a basis for the present section on Bovine Tuberculosis, and I am indebted to Staples Press for their courteous permission to make use of the earlier account. The whole subject of avian tuberculosis, including infection of wild birds, and of mammals, with avian tubercle bacilli, has been very thoroughly and ably reviewed by Feldman (1938a) and his book was of much assistance when dealing with these subjects.

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## INTRODUCTION

**B**OVINE tuberculosis is of great economic importance to the farming industry, and a serious danger to public health as man may be infected by direct inhalation of bovine tubercle bacilli, or by ingestion of infected milk and dairy products. The incidence of tuberculosis in cattle is described, and the methods of diagnosing, controlling, and eventually eradicating it are outlined. Already bovine tuberculosis has been virtually eradicated from Finland, the U.S.A., and the Scandinavian countries; and it is evident that its incidence will be reduced to very low levels in Great Britain, Canada, Australia, New Zealand, and probably several other countries within the next ten years.

The relationship of the three types of tubercle bacilli and of the human and bovine tuberculous epidemics are discussed. Infection of man with the bovine type of tubercle bacilli is described. A description of the so-called 'skin tuberculosis' of cattle, which is of importance because it sensitizes to tuberculin, is extended to include an account of somewhat similar conditions in buffaloes, and in man. The pathology, pathogenesis, and epidemiology of bovine tuberculosis are described, and tuberculosis in a variety of other animals and birds is dealt with in the later parts of the book.

Koch's original paper (1884) on the aetiology of tuberculosis contained a considerable amount of information on tuberculosis in animals. The first book on tuberculosis in man and animals was Straus's classical *La Tuberculose et son Bacille*, published in 1895. As Pinner says (1945, 552): 'One is again and again amazed to find how relatively little has been added to the basic knowledge contained in this work.' Calmette's *L'infection Bacillaire et la Tuberculose*, 4th edition, revised by Boquet and Nègre, is a valuable source of information and contains excellent coloured illustrations of tuberculous lesions in various animals. Cobbett's *The Causes of Tuberculosis* (1917) is invaluable as a guide to the massive reports of the British Royal Commission on Tuberculosis. The Commission's numerous experiments, obviously performed with great care, carry more conviction than some of the recent work on tuberculosis, and these reports still represent the best source of information on many aspects of tuberculosis in animals; they did much to clarify the relationship of the three main types of tubercle bacilli. In order to facilitate reference to these reports their contents are included in an appendix. One feels that in the establishment of the Royal Commission's experimental farms and the planning of work, Sir John M'Fadyean's great knowledge of agriculture and animal pathology must have been invaluable.

Feldman (1938a) provided an admirable account of avian type infection, and Rich (1944 and 1951) wrote 'by far the most important book on the pathogenesis of tuberculosis'. In fact, it is more than a book on tuberculosis as it deals exhaustively with the whole question of infection and resistance. Rich's book inevitably contains much information about tuberculosis in animals, but it is not presented in such a way as to give a picture of the diseases in each species.

My purpose has been to provide a modern account of tuberculosis in all the species in which there is reliable information. Where large works have been cited the page number, in italics, has usually been included to facilitate reference. The information for each species is summarized on pages 101 and 275, and in the final chapter an attempt is made to present a closer comparison between the pathology and epidemiology of tuberculosis in man and animals than has previously been done, and to introduce some unifying concepts. Thus table 51 (p. 294) indicates that characteristic 'tubercles' occur only in animals that develop a fairly high degree of allergy. With smaller degrees of allergy lesions are less characteristic and there is no tubercle formation in rats and mice. It is also shown that the varying intrinsic toxicity of mycobacteria is profoundly modified by the degree of allergy produced in the different species (Table 52, p. 299) and that allergic sensitivity varies in different areas of the skin. Consequently some sites are much more suitable than others for performing the tuberculin test in the various species. Tables 55, 56 and 57 (pp. 305-308) show survival times of animals infected experimentally with virulent tubercle bacilli. They therefore provide a basis for assessing the virulence of other strains of bacilli.

The study of disease in the domestic animals is sometimes spoken of as comparative pathology, but when performed for its own practical ends it belongs to the field of veterinary medicine, just as the study of disease in man belongs to human medicine. It is only when a disease is studied in a variety of species, often including man, in an attempt to obtain a better understanding of the processes involved, that one may legitimately speak of comparative pathology. As Francis Bacon wrote, 'No one can justly or successfully discover the nature of any one thing in that thing itself, or without numerous experiments which lead to further inquiries'. Tuberculosis offers an ideal field for the application of the comparative method, and it is hoped that the account which follows will contribute to the better understanding of tuberculous disease as a whole and provide a general picture of the disease at a time when a determined effort is being made, in both the medical and veterinary fields, finally to overcome the infection. In this connection it is interesting to note that in my book on *Bovine Tuberculosis* published just ten years ago, I concluded that the disease would be practically eradicated from Great Britain in 30-40 years. The Attested Herds Scheme has now made such progress that it seems probable this goal will be reached in another ten years. The eradication of tuberculous infection from the human population is a much more difficult task but this aim is being more and more widely accepted as the ultimate objective.

This book arose following a request from Professor F. R. G. Heaf to prepare an account of Bovine Tuberculosis for inclusion in a Symposium on Tuberculosis. When this request was extended to cover tuberculosis in other animal species the material became too large for inclusion in the Symposium, and an abridged version was prepared and included in the *Symposium of Tuberculosis* published by Cassell and Company Ltd., in 1957. The publishers kindly agreed, however, to publish the full account as a separate work, and in order for this to be complete there is inevitably some repetition.

# CONTENTS

	PAGE
INTRODUCTION	VX
BOVINE TUBERCULOSIS	
The Incidence of Bovine Tuberculosis .. .. .	3
Pathogenesis and Pathology .. .. .	11
Immunization .. .. .	44
The Detection of Tuberculous Cattle .. .. .	52
Control of Tuberculosis in Cattle .. .. .	70
Bovine-Type Infection in Man .. .. .	83
SUMMARY .. .. .	101
REFERENCES TO BOVINE TUBERCULOSIS .. .. .	107
TUBERCULOSIS IN ANIMALS OTHER THAN BOVINES	
Monkeys .. .. .	115
Guinea-Pigs .. .. .	126
Rabbits .. .. .	134
Voles .. .. .	154
Elephants .. .. .	162
Buffaloes .. .. .	163
Goats .. .. .	165
Sheep .. .. .	171
Camels .. .. .	174
Pigs .. .. .	177
Horses .. .. .	192
Asses and Mules .. .. .	203
Dogs .. .. .	204
Cats .. .. .	217
Mink and Silver Foxes .. .. .	222
Ferrets .. .. .	224
Hamsters .. .. .	225
Mice .. .. .	226
Rats .. .. .	237
Wild Animals .. .. .	242
Avian Tuberculosis .. .. .	249
Wild Birds .. .. .	264
Chick Embryo .. .. .	272
Cold-Blooded Animals .. .. .	274
SUMMARIES .. .. .	275

## A COMPARISON OF THE PATHOLOGY AND EPIDEMIOLOGY OF TUBERCULOSIS IN ANIMALS AND MAN

	PAGE
Classification of Species according to the Reaction provoked by Tubercle bacilli ..	293
The Ideal Experimental Animal .. .. .	296
Relationship between the Number of Bacilli and the Degree of Allergy ..	298
Distribution of Lesions .. .. .	300
Virulence of Tubercle bacilli for Various Species .. .. .	301
The Basis of Species resistance to Tubercle Bacilli .. .. .	311
Natural Infection of Various Species with Tubercle Bacilli .. .. .	312
<b>APPENDIX</b>	
The reports of the British Royal Commission on Tuberculosis .. .. .	316
REFERENCES TO OTHER ANIMALS AND COMPARATIVE PATHOLOGY ..	326
INDEX .. .. .	339

# LIST OF PLATES

			FACING PAGE
I	1.	Small primary focus in lung of a young bull	16
	2.	Mediastinal node showing calcification, caseation, and typical tuberculous process	
	3.	Probably the first accurate illustration of bovine tuberculosis	
II	1-3.	Bovine tuberculosis showing the variety of lesions which may be present in one animal	16
III	1-4.		
IV	1.	Bronchogenic phthisis in man	17
	2.	Section of thorax and abdomen of a cow showing pericarditis and extensive lesions on pleura and peritoneum	
	3.	Portion of bovine lung. Aspiration of tubercle bacilli has produced lobular caseous lesions	
V	1.	Peritoneal surface of small intestine and mesentery with firm nodular fibrous tubercles	24
	2, 3.	Tuberculous ulceration of bovine intestine	
	4.	Hypertrophic tuberculous lesions of the intestine	
VI	1.	A common result of miliary seeding of the mucosa in tuberculous cows	25
	2.	Foetal cotyledon showing caseo-calcareous lesions	
	3.	Hepatic nodes of a congenitally infected calf	
VII	1.	Caudal mediastinal node of a congenitally infected calf showing caseo-calcareous lesions	40
	2.	Bronchial nodes of a congenitally infected calf showing caseo-calcareous lesions	
	3, 4.	So-called skin tuberculosis in cows	
	5.	<i>Lepra bubalorum</i>	
VIII	1, 2.	<i>Lepra bubalorum</i>	41
IX	1.	Guinea-pig. Generalized tuberculosis after intranasal inoculation of virulent human tubercle bacilli	48
	2.	Guinea-pig. Disease of 'reinfection' type after vaccination with avirulent strain followed later by innoculation as in Fig. 1	
X	1-6.	Bovine tuberculosis. Reaction following injection of tuberculin into the caudal fold	49

XI	1-3.	Lungs of monkey with natural tuberculosis	118
XII	1, 2.	Lung of monkey with natural tuberculosis	119
	3.	Lung of monkey infected intranasally with human tubercle bacilli	
XIII	1.	Lung of monkey infected intranasally with human tubercle bacilli	120
	2, 3.	Lung of monkey infected as in Fig. 1; treated with streptomycin for 76 days	
XIV	1.	Higher magnification of Plate XIII, 2 and 3	120
	2, 3.	Lung of monkey inoculated intranasally with human tubercle bacilli. Treated for 8 weeks with <i>p</i> -ethylsulphonylbenzaldehyde thiosemicarbazone	
XV	1.	Lung of monkey with natural generalized tuberculosis	121
	2, 3.	Natural tuberculosis in a monkey that reacted to the tuberculin test but appeared in normal health	
XVI	1, 2.	Lung, liver and spleens of guinea-pigs infected with human tubercle bacilli	128
XVII	1.	Bronchial lymph-nodes in a naturally infected guinea-pig	129
	2, 3.	Lung and liver of guinea-pig infected with virulent human tubercle bacilli	
XVIII	1, 2.	Lungs of guinea-pigs inoculated with bovine tubercle bacilli	136
	3.	Bronchial lymph-node of guinea-pig vaccinated, then infected intranasally, with human tubercle bacilli	
XIX	1.	Normal and tuberculous lungs and tracheobronchial lymph-nodes of guinea-pig and rabbit compared	136
	2-4.	Lungs and kidney from rabbit infected intravenously with bovine tubercle bacilli	
XX	1, 2.	Lung and kidney of rabbit infected intravenously with bovine tubercle bacilli	137
	3, 4.	Lung and liver of rabbit infected intravenously with avian tubercle bacilli	
XXI	1.	Spleen of rabbit infected intravenously with avian tubercle bacilli	137
	2.	Lungs of rabbit infected intratracheally with bovine tubercle bacilli	
	3, 4.	Lungs and heart of mouse infected intraperitoneally with vole acid-fast bacilli	
XXII	1.	Lung of mouse infected intraperitoneally with vole acid-fast bacilli	160
	2.	Heart of mouse infected intravenously with vole bacilli	
	3, 4.	Lung and liver of rabbit infected intravenously with vole acid-fast bacilli	

			FACING PAGE
XXIII	1.	Mesenteric lymph-node of sheep. Fibro-caseous lesions caused by bacilli of the avian type	172
	2.	Sheep: lung. Multiple encapsulated lesions caused by bacilli of the avian type	
	3.	Sheep: spleen. Numerous conglomerate tubercles produced by bacilli of the avian type	
XXIV	1.	Sheep: lung. Typical tubercle produced by bacilli of the avian type	173
	2.	Sheep: liver. Well encapsulated tuberculous nodule produced by bacilli of the avian type	
XXV	1.	Pig: lung. Numerous nodular lesions produced by bacilli of the bovine type	184
	2.	Pig: lung. Tuberculosis produced by bacilli of the bovine type	
XXVI	1.	Pig: bronchial lymph-node. Dense peripheral encapsulation and pronounced calcification produced by bovine bacilli	184
	2.	Pig: spleen. The dense fibrous encapsulation with caseation and calcification is characteristic of bovine type infection	
XXVII	1.	Pig: mesenteric lymph-node. Lesion produced by tubercle bacilli of the avian type	185
	2.	Pig: bronchial lymph-node. Note moderate number of giant cells, diffuse fibrosis and slight caseation produced by bacilli of the avian type	
XXVIII	1.	Pig: liver. Intralobular tuberculous process with some caseation necrosis but no calcification. Avian type infection	185
	2.	Pig: liver. Penetration of the wall of a blood vessel by a diffuse tuberculous process. Avian type infection	
XXIX	1, 2.	Lung and spleen of horse showing innumerable miliary foci	200
XXX	1, 2.	Liver and diaphragm of horse shown in Plate XXIX	200
XXXI	1, 2.	Higher magnifications of lung and diaphragm shown in Plates XXIX and XXX	201
	3.	Horse. Lesions of acropachia	
	4.	Horse. Part of mandibular lesion	
XXXII	1-3.	Bronchial lymph-node, spleen and liver of dog infected intravenously with human tubercle bacilli obtained from another dog	201
XXXIII	1.	Lung of naturally infected dog with multiple lesions	208
	2.	Lung of dog infected intratracheally with human tubercle bacilli. Treated with dapsone	
	3.	Lung of dog infected intratracheally with human tubercle bacilli	

			FACING PAGE
XXXIV	1, 2.	Lungs of dogs infected intratracheally with human tubercle bacilli	208
	3.	Lung of dog infected into lung with a strain of canine origin	
XXXV	1, 2.	Lung and pleura of dog infected into lung with human tubercle bacilli	209
XXXVI	1-3.	Dog, lungs. Roentgenograms taken 2, 8 and 62 weeks after infection of tubercle bacilli into each lung	209
XXXVII	1.	Tuberculous lesion in fundus of eye of a cat	232
	2-4.	Lungs of mice infected intravenously with bovine tubercle bacilli	
XXXVIII	1.	Lung of mouse infected intravenously with human tubercle bacilli	233
	2.	Lung of mouse infected with bovine tubercle bacilli	
	3, 4.	Lung and liver of rats infected intraperitoneally with a suspension of rat leproma	
XXXIX	1.	Chicken: femur. Tuberculous lesion in the marrow	256
	2-4.	Tuberculous lesions in chicken liver and intestine	
XL	1.	Duck embryo: chorio-allantois. Infected with bovine tubercle bacilli	257
	2.	Chick-embryo. Human tubercle bacilli were inoculated into the yolk sac	

*BOVINE TUBERCULOSIS*



## CHAPTER I

# THE INCIDENCE OF BOVINE TUBERCULOSIS

**T**HE incidence of tuberculosis varies in different types and ages of cattle, and before describing the percentage of infected animals it will be useful very briefly to outline the natural history of the disease.

The striking fact about primary tuberculous infection in man is that as a rule lesions heal, giving rise to 'the familiar non-progressive globular little lesions of the primary complex'. Hence a large proportion of the population reacts to the tuberculin test but does not spread infection. It is the person with bronchogenic phthisis of the 'reinfection type' who chiefly spreads the disease. In cattle the position is quite different. Only about 10% of British cattle would have reacted to the tuberculin test in 1952, but almost all of these had open, though not acute, pulmonary tuberculosis of the bronchogenic type.

This difference between man and cattle has long been obvious, but our knowledge of bovine pulmonary tuberculosis has been put on a much firmer basis by Stamp (1948). It appears that when either calves or adult cattle become infected for the first time, by the aerogenous route, the result is usually a slowly progressive bronchopneumonia; and reinfection, either endogenous or exogenous, also gives rise to a bronchopneumonia. Calves that are housed with cows are exposed to a constant risk of infection by the aerogenous route, but when they are not housed with cows about 90% of them reach maturity (two years) without being infected. This is usually true even if they are pastured with cows, for the danger of infection at pasture is far less than in the cowshed. The risk of calves being infected by milk is not great, for only about 1% of tuberculous cows have tuberculosis of the udder: when it does exist, however, tuberculosis of the udder is a grave danger because if one cow has the disease it may infect all the calves fed on the mixed milk of the herd. Beef cattle are killed at two or three years of age, and figures obtained at meat inspection show that the incidence in these animals is only 5 to 15%. After parturition a heifer enters the cowshed and in many dairy herds she is exposed to heavy aerogenous infection during the rest of her life and the incidence rises steadily. Fig. 1 shows the average incidence of tuberculosis at various ages.

## FACTORS INFLUENCING THE INCIDENCE OF TUBERCULOSIS

It is obvious that age influences the incidence of tuberculosis and it will be seen from

Fig. 1 that on the average in Europe it increases steadily from nearly 0 at birth to 35% at 5 years of age.

In 1905 42.8% of dairy cows supplying milk to Paris reacted to tuberculin and the following age incidence was found (Boquet and Nègre, 1936, 460):

Age	No. tested	Percentage reactors
4 years and under	330	25.47
5 " " "	1,276	29.85
6 " " "	2,533	32.37
7 " " "	3,326	35.59
8 " " "	3,067	37.85
9 " " "	1,831	30.42
10 " " over	2,695	35.10

Straus (1895, 323) gives the following data on age incidence based on abattoir statistics:

Age	No. Tuberculous	Percentage of Total
Under 6 months	208	0.4
6 months to 1 year	312	0.6
1 to 3 years	5,852	11.4
3 to 6 years	16,993	33.1
6 years and over	22,279	43.4

Moule (1948) tuberculin tested a stud herd of 847 cattle which ranged extensively over an area in Australia with an average annual rainfall of 10 inches. There were 13.1% reactors and when these were divided into age groups the yearly increase was similar to that shown in the lowest curve of Fig. 1. Autopsies on bulls indicated that infection was by the aerogenous route in 84% and it is thought that infection was acquired when animals congregated at waterholes and when 'playing and fighting'. Some herds on extensive properties reveal an even higher incidence of tuberculosis although in most the incidence is much lower. Thus in 15,000 dairy animals on the Darling Downs only 0.7% reacted and 300 of 360 herds were free from tuberculosis. A similar low incidence was found in some 6,000 dairy animals on the Atherton Tableland in North Queensland (Maunder, 1948, personal communication). These animals were Jerseys and Short-horns and were brought into yards or sheds for milking although many were not fed in the sheds. It appears that there is quite a high incidence of tuberculosis in cattle under ranching conditions in South Africa (Robinson, 1953, see also p. 314).

It often causes some surprise that tuberculosis should reach any appreciable incidence in cattle on extensive properties, although it has been known since 1900 that the incidence may sometimes be high in cattle in Australia that are seldom or never housed (Francis, 1947). Again it is well known that pleuropneumonia may be a serious disease on extensive properties; and as pleuropneumonia is produced by droplet infection there is no reason