

NATURALLY ACQUIRED TUBERCULOSIS IN VARIOUS ANIMALS

SOME UNUSUAL CASES

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THE cases of tuberculosis here reported occurred naturally in a bat, a bear, a bison, a hedgehog, a kangaroo, a mink, a goat, a horse, a calf and a parrot.

The bat, bear, hedgehog and kangaroo died in the Gardens of the Zoological Society, London, and I am greatly indebted to Col. A. E. Hamerton, F.Z.S., for the specimens of tuberculous tissues and for permitting me to quote from his descriptions of the lesions found at the autopsies. The goat and the calf had been bought for purposes of experiment; they, however, reacted to the tuberculin test and were slaughtered. The specimens from the horse were sent by Mr W. J. Leyshon, M.R.C.V.S., Veterinary Officer, London County Council, those from the bison and the mink by the Institute of Animal Pathology, Cambridge, and those from the parrot by Dr T. Hare, London. Tubercle bacilli were obtained in culture from each animal and tested in the usual way in order to determine their type.

An account is given of the results of the bacteriological investigation of each case together with an abstract of the post-mortem findings.

BEAR

A Sun Bear (*Ursus malayanus*) died in the Zoo in October, 1930. The cause of death was tuberculosis of the lungs in which there were caseous areas and cavities. The mesenteric glands were tuberculous, and one suprarenal body was composed of tough, yellowish white, caseous substance. Film preparations from the lung and adrenal showed very numerous tubercle bacilli, mainly short and uniformly stained; emulsions of both organs produced general tuberculosis in two guinea-pigs. A culture of tubercle bacilli obtained directly from the lung was dysgonic and produced general tuberculosis in a rabbit inoculated subcutaneously, the kidneys showing numerous projecting nodules.

EUROPEAN BISON

The bison (*Bos bison*) had lived free in a park where cattle also grazed. The necropsy showed generalised tuberculosis. The lungs were closely beset with caseous tubercles and irregular masses of aggregated tubercles, some of which

were gritty; the nodules were for the most part firm and dense, but some were softened and a few showed small cavities. The pleura was greatly thickened, dense, caseous and gritty. The mesenteric glands were enlarged, hard and nodular, and composed of calcareo-caseous substance surrounded and intersected by fibrous tissue. Tubercle bacilli were extremely numerous in the lung pus and moderately numerous in the pleural and mesenteric gland lesions.

Emulsions of lung, pleura and mesenteric glands caused rapidly fatal generalised tuberculosis in guinea-pigs. A culture of tubercle bacilli from the lungs was dysgonic and virulent for a rabbit, the animal, inoculated subcutaneously, dying in 53 days of severe general tuberculosis.

INDIAN FRUIT-BAT

The bat (*Pteropus giganteus*) was received into the collection of the Zoological Society in 1922 and died in July, 1930.

Autopsy (by Col. A. E. Hamerton). About 100 c.c. of slightly blood-stained fluid in peritoneal cavity; tuberculous peritonitis; miliary tubercles on peritoneal surfaces of liver and spleen; intestines glued together by recent peritoneal adhesions; hyperaemia of walls of intestines and catarrh of mucous membrane; no tuberculous lesions found in gut. Liver and spleen enlarged and congested, no tuberculous lesions found in substance of these organs: hepatic lymphatic glands enlarged and caseous (t.b. + +). Mesenteric glands enlarged and caseating (t.b. + +), one, sent to Cambridge, being the size of a Barcelona nut and composed of calcareo-caseous substance and caseo-pus. Lungs, oedematous, showed grey patches of consolidation.

A little of the pus from the mesenteric gland was injected subcutaneously into two guinea-pigs. They died of caseo-necrotic general tuberculosis in 70 and 72 days. A culture of tubercle bacilli obtained directly from the pus was dysgonic (bovine Class I) and highly virulent for a rabbit, which died of severe generalised tuberculosis 56 days after subcutaneous inoculation of less than 5.0 mg. of the culture.

This is the second fruit-bat which I have examined and from which I have cultivated bovine tubercle bacilli. The first fruit-bat (*Pteropus medius*) died in the Zoo in 1925 of severe thoracic tuberculosis, the right lung being massive and caseous and the right bronchial glands enlarged and caseous throughout. In this bat there were no tuberculous lesions in the abdominal organs or glands.

The fruit-bats at the Zoo are fed on bananas, grapes and dates with a little tinned sterilised milk occasionally. They are never given raw fresh milk.

The bat now reported on had been over 7 years in the collection and Col. Hamerton did not think it likely that the animal was already infected on arrival.

HEDGEHOG

In November, 1932, Col. A. E. Hamerton sent me the lungs of a common English hedgehog (*Erinaceus europaeus*) which had been caught in Regent's Park 6 weeks before it was deposited in the Zoo, where 5 weeks later it died of

tuberculosis of the lungs of the "grey hepatisation" type. The lungs were consolidated, dark red, with lighter greyish yellow areas about 5 mm. in diameter, not caseous. A cover-slip preparation showed acid-fast bacilli in great abundance; they varied in length from quite short to moderately long bacilli; many were beaded. Although the lungs were much decomposed I was able by means of sulphuric acid (3 per cent. in the mixture) to obtain a pure culture of tubercle bacilli directly from the lung. On plain egg, numerous typical "bovine" colonies appeared, while on 5 per cent. glycerin egg only one colony grew. In subculture the strain was highly dysgonic (Class I). A dysgonic culture identical with the direct strain was also obtained by means of sulphuric acid from an enlarged necrotic inguinal gland of a guinea-pig, which died of extensive subcutaneous cellulitis 15 days after inoculation of a very small amount of the original untreated lung emulsion. Two guinea-pigs inoculated subcutaneously with the lung emulsion previously treated with 2.5 per cent. KOH, escaped cellulitis and died of general tuberculosis in 55 and 60 days. The virulence of the strain was also tested on a rabbit by subcutaneous inoculation of culture in a dose of 2-3 mg. The rabbit died in 34 days of severe general miliary tuberculosis. The death of the hedgehog was due therefore to an infection with virulent bovine bacilli. Col. Hamerton remarked that "as the animal had been nearly three months in captivity it may have been infected with tuberculous cows' milk given as food. Inquiries from park keepers and shepherds in Regent's Park have not convinced me that hedgehogs can be included in the indigenous wild fauna of inner London. It is not unlikely that discarded pet hedgehogs may occasionally be found there."

My experiments for the Royal Commission on Tuberculosis showed that the hedgehog can be made tuberculous by feeding with bovine tubercle bacilli. Tuberculosis was, however, not readily produced in this way and, of the ten animals which were fed with infected milk, four only showed macroscopic lesions, which, except in one with tubercles in the omentum, was limited to the glands of the head and neck (submaxillary, retropharyngeal or cervical). Tubercle bacilli were numerous in the caseous lesions and in two instances were found in the mesenteric glands and in one instance in the spleen, though this organ and the glands were not macroscopically tuberculous. Of the six hedgehogs which escaped infection, two were fed once and one for 43 days with tuberculous milk and three received each a single dose of culture (10, 1 and 1 mg.), the periods of observation being 26, 43, 47, 55, 72 and 111 days.

Subcutaneous inoculation of a large dose of bovine bacilli (1.0 mg. of culture) produced general miliary tuberculosis in two hedgehogs, but after a small dose of bacilli (50,000) the tuberculosis 45 days later was limited to the seat of inoculation and adjacent glands. The hedgehog is clearly susceptible to the action of the bovine tubercle bacillus but its susceptibility is definitely less than that of the guinea-pig or rabbit.

KANGAROO

A black-faced kangaroo (*Macropus giganteus melanops*) in the collection of the Zoological Society of London died in November, 1931, from tuberculosis of the pancreas. At the necropsy Col. A. E. Hamerton found that the pancreas was much enlarged by the presence within its substance of a firm tumour, 1-1½ in. in diameter, which on section was composed of dense yellowish white substance with scanty translucent tissue around the margins. A few small nodules of a similar nature were distributed throughout the gland. On microscopical examination the tumour was found to be a tuberculoma containing much fibrous tissue, necrotic areas, lymphoid cells and endothelial cells with nests of acid-fast bacilli. Careful search through the lungs and the alimentary and the lymphatic systems failed to reveal a primary lesion in any of these tissues, the only other tuberculous focus found being a minute tubercle containing acid-fast bacilli in the capsule of a kidney.

Bacteriological investigation. A suspension in salt solution of pounded tuberculoma, which microscopically showed extremely numerous acid-fast bacilli, mainly short, was used for cultures and the inoculation of two guinea-pigs. One guinea-pig died in 42 days; there was no local lesion but the inguinal glands were a little enlarged and contained firm opaque white foci. The other guinea-pig died of pneumonia in 139 days; no lesions of tuberculosis were found either locally, in the adjacent glands or in the organs.

Cultures of acid-fast bacilli were obtained directly from the tuberculoma by means of sulphuric acid and from the inguinal glands of each guinea-pig. Colonies were extremely numerous from the tuberculoma and the first guinea-pig; they were few in number from the second guinea-pig. The characters of the colonies and of the subcultures from each source were those of the avian type of tubercle bacillus.

The results of the following virulence tests with the direct strain on two guinea-pigs, three rabbits and two fowls confirmed this classification of the bacilli.

Guinea-pig 1. 0.1 mg. intrap., died 49 days. P.M.: Omentum rolled up and thickened, contained small abscesses. Mesenteric glands slightly enlarged, with caseo-necrotic areas in cortices. Spleen, one pinhead tubercle. Liver, a few grey foci. Lungs, emphysematous, no tubercles.

Guinea-pig 2. 0.1 mg. subcut., died 169 days. P.M.: No local lesion. One inguinal gland, a purulent focus 3 mm. No sign of tuberculosis internally. Death from pneumonia (pneumococcal).

Rabbit 1. 0.1 to 0.2 mg. intrav., died 16½ days. P.M.: Lungs, two or three minute translucent grey foci. Spleen greatly enlarged, packed with yellow tubercles, parts being necrotic and haemorrhagic. Liver speckled with minute grey and yellow foci. Acid-fast bacilli were extremely numerous in liver, spleen and marrow, and were cultivated directly from the blood.

Rabbit 2. 5.0 mg. subcut., died 35 days. P.M.: Caseous local lesion. Ad-

jacent scapular glands caseous throughout. Other lymph glands free from macroscopic lesions. Liver and spleen greatly enlarged, very closely beset with submiliary whitish tubercles. Lungs, kidneys and pericardial surface of heart showed scattered submiliary tubercles.

Rabbit 3. 5.0 mg. subcut., died 82 days. P.M.: Large ulcerated caseo-necrotic lesion. Adjacent (scapular) glands large and caseous throughout. Other glands free. Lungs enlarged and consolidated with reddish grey coalescing tubercles, caseous centrally. Pleurae showed flattened caseous tubercles. Spleen, numerous miliary tubercles on surface and in depth. Liver, moderately numerous just visible foci. Kidney cortices closely beset with caseous tubercles ranging from a mere point up to a millet seed, the larger projecting; on section they penetrated deeply as radial streaks and there were also discrete tubercles in the medullae; the capsules were tuberculous, thickened and oedematous. Omentum contained numerous caseous foci and tubercles and there were tubercles along the mesenteric vessels and in the appendix and areolar tissues. Many joints showed early tuberculosis of the synovial membranes. The lachrymal glands contained tubercles.

The tuberculosis in the last two rabbits was unusually severe to follow subcutaneous inoculation of avian tubercle bacilli and hardly to be distinguished from tuberculosis caused by bovine bacilli. According to F. Griffith, the tuberculosis set up in rabbits by the subcutaneous inoculation of avian tubercle bacilli is very chronic and has a characteristic distribution no matter how varied the doses may be. I have seen only one previous case of general avian tuberculosis after subcutaneous inoculation approaching these in severity (the rabbit was killed when dying, 91 days after 10.0 mg. of culture of avian bacilli from a sheep). In order to make quite certain that there were no bovine bacilli in the culture used for the rabbit I inoculated two guinea-pigs subcutaneously with an emulsion of a kidney nodule of rabbit 3. The guinea-pigs were killed 153 days later and showed nothing beyond small abscesses locally and in the adjacent glands. Avian tubercle bacilli were recovered from the lesions.

Fowl 1. 0.1 mg. intrav., died 32 days. P.M.: Submiliary tuberculosis of liver and spleen. Tubercle bacilli numerous in the organs and in the marrow.

Fowl 2. 10.0 mg. intramusc., died 55 days. P.M.: Pectoral muscle extensively replaced by caseo-necrotic substance. Liver and spleen closely beset with small greyish-white tubercles. Lungs enlarged and congested and exceptionally closely beset with miliary caseating coalescing tubercles. Heart muscle, many caseating tubercles. Tubercle bacilli were very numerous in the lesions.

The results of the bacteriological investigation show conclusively that the acid-fast bacilli from the pancreatic tuberculoma of the kangaroo were fully virulent avian tubercle bacilli. The lesion was of old standing and it is interesting that the avian bacilli were unaltered in cultural characters or in virulence through long residence in the tissues of the kangaroo.

This is the fifth case of tuberculosis in a marsupial animal in which the types of tubercle have been determined.

The particulars of the cases are summarised in Table I.

Table I

No.	Species of animal	Distribution of tuberculosis	Bacteriological examination by	Type of bacillus
1	Rat-Kangaroo (<i>Epyprymnus rufescens</i>)	One mesenteric gland purulent. Liver discrete tubercles	N. Lucas	Avian
2	„	Lungs: extensive tuberculous pneumonia	A. S. Griffith	Bovine
3	Kangaroo (<i>Macropus fuliginosus</i>)	Widespread glandular tuberculosis. Miliary tubercles in lungs and spleen, one shoulder joint and both sterno clavicular joints	A. S. Griffith	Avian
4	Wallaby (?)	Mesenteric glands: one much enlarged, showed advanced caseation; a few others affected to a less degree. Liver and spleen riddled with miliary tubercles. Kidneys, a few tubercles. Portal gland, large and caseous and slightly calcified	Stableforth	Avian
5	Kangaroo (<i>Macropus giganteus melanops</i>)	Pancreas, one large and a few small nodules. One tubercle in capsule of a kidney	A. S. Griffith	Avian

MINK

The mink died at a farm for breeding these animals. The lungs only were sent for examination. They showed breaking down caseous areas in which acid-fast bacilli were found. The caseous substance produced general tuberculosis in a guinea-pig and yielded a culture of bovine tubercle bacilli.

GOAT

The goat, a nanny about 3 years old, was purchased for experiment, but reacted to the tuberculin test and was chloroformed in April, 1934.

Autopsy. In the mesentery of the ileum four fully calcified glands, ranging in size from a pea to a good-sized runner bean, were found. An ileo-caecal gland showed in the cortex a caseous area about the size of a barley grain. There were no macroscopic lesions anywhere else in the body.

Bacteriological investigation. One of the calcareous nodules was emulsified and inoculated subcutaneously into a guinea-pig. Acid-fast bacilli were not found in a film preparation. The guinea-pig killed 71 days later was free from tuberculosis and cultures from its inguinal glands remained sterile. The caseous focus was separately emulsified (short t.b. + + +) and inoculated subcutaneously into a guinea-pig which 70 days later was killed. The autopsy showed a local abscess (1.5 × 1.0 cm.) and hyperplasia of the adjacent inguinal glands one of which on each side contained a small abscess; there were no other lesions. Moderate numbers of acid-fast bacilli were found in the local and glandular pus and were obtained in culture from the local lesion, an inguinal gland and the spleen. The colonies were numerous from the lesion and the gland but only

two were obtained from the spleen. The characters of the cultures and the morphology of the bacilli were those of the avian tubercle bacillus. The culture was tested as to its virulence for the fowl and the rabbit. Two chickens were inoculated intra-muscularly each with 5.0 mg. One died in 37 days, the spleen and liver showing innumerable sub-miliary tubercles (t.b. + + +). The other was killed 93 days after inoculation and showed generalised tuberculosis, miliary tubercles being very numerous in the spleen (t.b. + +), moderate in number in the liver and sparse in the lungs. Four rabbits were inoculated, three intravenously with doses of culture ranging from 0.001 to 0.1 mg. and one subcutaneously with 29.0 mg. The intravenously inoculated rabbits died in from 46 to 58 days of general miliary tuberculosis with the characteristic distribution of subacute avian tuberculosis in the rabbit. The subcutaneously inoculated rabbit died in 252 days and showed the chronic form of avian tuberculosis which follows this method of inoculation: local abscess, purulent adjacent glands, little internal disease and multiple tuberculosis of joints and tendon sheaths.

The owner of the goat stated that the animal had ordinarily grazed on a railway embankment and at night lived in a shed to which during the day fowls had had access. Though no disease had been observed among the fowls, it is probable that they were the source of the avian bacilli.

This case is unique for two reasons. In the first place the lymphatic glands of the alimentary tract contained recent and active as well as calcified and obsolete lesions, indicating that the goat had been infected on two separate occasions.

In the second place avian tubercle bacilli have not before been demonstrated in a case of casual tuberculosis in a goat. The type of tubercle bacillus previously found has always been the bovine. This was so in a case reported by me in 1917, in which the channel of infection was the alimentary tract, the animal having been brought up by hand on unboiled cows' milk. Recently (1934) H. Schwabacher has obtained bovine tubercle bacilli from a case of natural tuberculosis in a goat with extensive pulmonary lesions.

Calmette states that in the goat the infection, due exclusively to bovine bacilli (human bacilli have very little virulence for the goat) usually assumes the pulmonary form, but cases of generalised tuberculosis in which the mamma or the supramammary glands may be implicated have not infrequently been observed. Goats therefore, contrary to general belief, may give tuberculous milk and should, especially when stalled with cattle, be periodically tested with tuberculin, to which the tuberculous goat reacts vigorously, before their milk can be considered free from risk of conveying tuberculosis if drunk in the raw state.

HORSE

A draught mare, 5 years of age, was slaughtered in London in March, 1930, and portions of the organs and a gland were sent to me by Mr W. J. Leyshon, M.R.C.V.S.

The spleen contained a moderate number of nodules ranging from about 0.5 up to 4 cm. in diameter; externally the nodules were yellowish white and on section homogeneous, dense and fibrous. The liver contained similar nodules up to 1 cm. in diameter. The lungs were filled with submiliary grey translucent tubercles. A mediastinal gland showed a fibrous nodule rather more than 1 cm. in diameter. The bronchial glands, the kidneys and the pleurae were stated to be normal.

After searing the surface of the spleen a nodule was removed and pounded in a mortar. It was extremely tough and not easily pulped. A suspension of the pulp was treated with KOH (2.5 per cent. in the mixture) and inoculated subcutaneously into two guinea-pigs. Both animals developed local disease but when killed 68 and 118 days later respectively showed no lesions internally. One guinea-pig showed a small local caseous abscess and an enlarged inguinal gland on each side containing a small collection of whitish pus. In the other guinea-pig there was no local lesion but a gland on each side contained a small abscess. Acid-fast bacilli, some long and curved, were found in the pus. Cultures of tubercle bacilli were obtained from each guinea-pig. The strains grew luxuriantly and were identical culturally with the eugonic human type of tubercle bacillus.

Virulence tests were made on eight guinea-pigs and two rabbits. These experiments are summarised in Table II.

Table II

Species of animal	Dose in mg.	Duration of life	Results
Intraperitoneal inoculations			
Guinea-pig	1.0	D. 18	Liver and spleen speckled with grey foci. No caseation of glands.
„	1.0	D. 26	Omentum slightly thickened; no peritoneal tuberculosis. Grey points in liver and spleen. A few tubercles in medullae of kidneys.
„	1.0	D. 43	Liver and spleen speckled with grey foci.
„	0.1	D. 118	No peritoneal tuberculosis. Hyperplasia of glands with caseation. Grey foci in liver and spleen.
„	0.01	D. 159	Typical chronic G.T. Liver and spleen much enlarged.
Subcutaneous inoculations			
„	1.0	K. 140	Small local ulcer. Inguinal glands enlarged, indurated, contained small abscesses. Other glands enlarged and fibroid. Liver and spleen contained grey miliary tubercles.
„	10.0	D. 408	Chronic severe G.T.
„	10.0	D. 226	Slight G.T.; lesions fibroid. Death from purulent pleurisy.
Intravenous inoculations			
Rabbit	0.01	K. 138	Lungs: slight marginal tuberculosis of anterior lobes and three superficial flat nodules in caudal lobes. Kidneys: caseo-pus in one calyx. A bone in each tarsus was slightly tuberculous. The vesiculae seminales were filled with thick white pus (t.b. + + +).
„	1.0	K. 287	Lungs: six tubercles and one split-pea-sized softened nodule. Kidneys: pitted, no tubercles. The mammary glands, two knee-joints and two tendon-sheaths were tuberculous.

As will be seen from Table II, the culture produced general tuberculosis in all the guinea-pigs inoculated. In two guinea-pigs this was severe and typical, but the duration of life of the animals was much longer than after similar inoculation with standard human bacilli. In the remainder of the guinea-pigs the disease was of mild type, the organs containing grey miliary tubercles and glands showing hyperplasia or fibrosis, without necrosis or caseation. For the rabbit the culture was of low virulence.

This is the first case of equine tuberculosis in this country from which tubercle bacilli of human type have been obtained. All the other cases, 54 in number, were caused by bovine bacilli, with the exception of one which yielded avian bacilli. The great majority of the bovine strains were less virulent for the test animals than standard bovine bacilli, and it is interesting that human tubercle bacilli—as this case shows—may also lose virulence for experimental animals during long residence in the tissues of the horse.

CALF

This case was investigated jointly with Mr R. E. Glover, F.R.C.V.S. As previously mentioned, the calf was bought for the purpose of experiment but it reacted to the tuberculin test and was slaughtered.

Autopsy. The middle lobe of the right lung showed two subpleural translucent grey foci of irregular outline, each rather less in size than a barley grain; no lesions were found elsewhere in the lungs. A gland in the middle region of the dorsal mediastinum contained two yellowish foci rather larger than those in the lungs. Other mediastinal and the bronchial glands, as also the rest of the carcass, showed no lesions. Acid-fast bacilli which were rather long, slender and beaded were found in cover-slip preparations from the pulmonary and glandular lesions.

The trivial nature of the lesions and the length and beadedness of the associated bacteria suggested that the infection might not be bovine and it was decided to determine the type of the bacilli.

Bacteriological investigation. Separate emulsions were made of a lung and a gland lesion and each was inoculated subcutaneously into a guinea-pig. A little of the thoracic gland emulsion was also used for cultures. One guinea-pig died in 104 days and the other was killed 171 days after inoculation; both showed extensive chronic general tuberculosis.

Cultures of tubercle bacilli were obtained directly from the mediastinal gland and through the guinea-pig from the lung and from the gland. The three strains all grew luxuriantly and were identical in cultural characteristics with the eugonic human type of tubercle bacillus. Virulence tests on three rabbits gave results in agreement with this classification of the bacilli.

Rabbit 1. Subcutaneous, 30.0 mg. of the lung strain; killed 143 days.

Autopsy. Large local caseous abscess; nearest glands normal; lungs crepitant, caudal lobes showed each one small grey caseating patch dorsally and a narrow zone of tuberculous tissue occupying the thin margin.

Rabbits 2 and 3 were inoculated intravenously each with 0.1 mg. of the mediastinal gland strain. They died in 142 and 220 days respectively and showed the chronic form of general tuberculosis which is not unusual after a relatively large dose of human bacilli. In rabbit 2 there were miliary caseous tubercles in the lungs, the tracheal and popliteal glands, the muscles, the areolar tissues particularly of the groins and axillae, and the skin, some of the cutaneous tubercles having ulcerated; the kidneys were pitted on the surfaces and the cortices were beset with submiliary caseous tubercles, the medullae showing radial caseous streaks and one calyx containing caseo-pus; the knee-, ankle- and wrist-joints were tuberculous, the disease seemingly having begun in the synovial membranes, since the epiphyseal bones were apparently not affected; one tarsal bone was necrosed; both eyes and lachrymal glands were tuberculous; other organs and glands were unaffected. Rabbit 3 showed a similar distribution of lesions but the tubercles were less numerous in lungs and kidneys and not observed in muscles and areolar tissues.

This is the second instance of naturally acquired tuberculosis in a calf from which tubercle bacilli of the human type have been obtained. The first instance, reported in 1913, was in a calf which had been reared on milk from cows which, as young calves, had been protectively vaccinated by intravenous inoculation with living human tubercle bacilli. The calf when a few months old was tested with tuberculin and reacted. It was slaughtered and, at the autopsy, slight tuberculosis limited to one mesenteric gland was found. A culture of tubercle bacilli obtained from this gland was of the human type. There is little doubt that the source of the human bacilli in this case was cows' milk, for it was shown subsequently that a heifer in the herd, which had been vaccinated when 4 days old, was excreting human bacilli along with her milk. The bacilli were recovered from the milk of the heifer at the beginning of lactation and during the following 12 weeks; then she was slaughtered. At the autopsy no lesions were found except in the lungs, which showed a minute grey subpleural tubercle. Emulsions, however, of the supramammary and bronchial lymphatic glands produced tuberculosis in guinea-pigs. From the guinea-pigs injected with supramammary gland, tubercle bacilli of human type were obtained in culture while, from the guinea-pigs injected with bronchial gland, tubercle bacilli of bovine type were cultivated. The presence of living human tubercle bacilli in the tissues had not therefore served to protect the animal from infection with bovine tubercle bacilli, which might or might not in time have produced progressive disease.

In the recent instance the infection was evidently of respiratory origin and may have been contracted from a phthisical person who—it was afterwards ascertained—had been in contact.

This case illustrates the undesirability of allowing phthisical persons to attend on tubercle-free cattle. When bacilli of the human type are transmitted the lesions produced may be trivial and eventually disappear, but until this happens the animal will react to the tuberculin test.

The human, however, is not the only type of tubercle bacillus which may be conveyed to cattle by attendants. The bovine bacillus can cause in man those forms of tuberculosis, namely pulmonary and renal phthisis, which are characterised by a more or less abundant discharge of bacilli to the outside. Persons so affected in attendance on healthy cattle may be as dangerous as a tuberculous cow unwittingly introduced into the herd.

PARROT

The head of a parrot was sent to me by Dr Tom Hare, M.D., M.R.C.V.S., from the Royal Veterinary College, London on June 27, 1933.

On the right mandible, extending from just below the external ear to the angle of the jaw, there was a raised disc-shaped tumour about 2 cm. in diameter, the central part of which was ulcerated and covered with a black scab. On removing the latter, cheesy caseous substance was found within a somewhat fleshy thick wall. A small gland on the same side in the upper part of the neck, rather larger than an oat grain, was caseous. There were no tuberculous lesions in the thorax or in the abdomen. Film preparations of caseous substance from the cutaneous lesion and the cervical gland showed beaded tubercle bacilli in moderate number. Cultures of tubercle bacilli were obtained directly—with the aid of sulphuric acid—from the skin lesion and from the gland. Both strains grew luxuriantly, exhibiting the cultural characters of the eugonic human type of tubercle bacillus. A guinea-pig inoculated subcutaneously with an emulsion of caseous substance from the cervical gland died in 150 days of typical severe chronic general tuberculosis. The results of the investigation show that the parrot was infected with virulent tubercle bacilli of the human type.

This case is unusual only in one particular, namely, the occurrence of tuberculosis of a cervical gland; this extension of the disease, so far as I have been able to ascertain, has not previously been described. The source of the bacilli was in all probability a young man who had, for some time, slept in the room containing the parrot and who, after the destruction of the latter, was sent to hospital suffering from pulmonary tuberculosis.

Tuberculosis in the pet parrot generally takes a cutaneous form and is caused by human tubercle bacilli transmitted by tuberculous owners in the act of feeding or fondling the bird. The disease begins in the skin of the head (eyelids, root of beak, ears, etc.) as a small nodule, which gradually extends and eventually ulcerates, the floor of the ulcer becoming covered with a warty or horn-like excrescence. Stableforth (1929) has described a case where the lesion was in an eyelid; the bacilli obtained in culture were of the human type. The internal organs of the parrot may be free, but when they are affected it is the lungs that suffer most (Cobbett). In Zoological Gardens, tuberculosis among parrots is uncommon and is caused by the avian type of bacillus (Koch and Rabinowitsch, 1907).

It is interesting to recall that experimentally the parrot is susceptible to bovine, human and avian bacilli, all three types being capable of producing

generalised progressive tuberculosis. When working for the Royal Commission on Tuberculosis (1911), I tested the susceptibility of the parrot to human tubercle bacilli and showed that this type of bacillus produced general tuberculosis after intravenous, intramuscular and cutaneous inoculation. One parrot infected cutaneously—by scarifying the skin at the root of the beak with a scalpel, the point of which had been dipped in a turbid suspension of culture of virulent human bacilli—died in 250 days of severe general miliary tuberculosis but, surprisingly, did not show any local tuberculosis. Other workers have however succeeded by means of scarifications in setting up verrucous focal lesions at the seats of implantation of the human bacilli. F. Griffith (1911) tested the comparative susceptibility of the parrot to bovine and avian bacilli. The results indicated that the bovine was more virulent than the avian bacillus. Weber, Titze and Weidanz (1908) came to the same conclusion, adding that the avian was the least virulent of the three.

SUMMARY

In this paper the pathological and the bacteriological findings in ten instances of naturally acquired tuberculosis in ten different species of animals are recorded. The tubercle bacilli obtained in culture from five species (bat, bear, bison, hedgehog and mink), all cases of fatal tuberculosis, were of the bovine type. The bacilli from a case of localised glandular tuberculosis in a goat and one of tuberculosis of the pancreas in a kangaroo were of the avian type. The bacilli from a case of generalised retrogressive tuberculosis in a horse, of minimal thoracic tuberculosis in a calf and cutaneous and glandular tuberculosis in a parrot were of the human type. These results amplify the evidence already published which shows that each of the three types of tubercle bacilli (bovine, human and avian) is able to cause natural tuberculosis in many different species of animals other than that which is its normal habitat.

The bovine bacillus which is transmitted to animals almost exclusively by tuberculous bovines is responsible for the greater part, especially the generalised and fatal forms, of the tuberculous disease occurring naturally in farm and domestic mammals and for a not inconsiderable amount of tuberculosis in human beings.

The avian bacillus whose natural host is the domestic fowl can infect casually many species of mammals, namely the pig, the ox, the sheep, the goat, the horse, the guinea-pig and the rabbit and in Zoological Gardens several marsupial species. Instances of its transmission to the different species of farm mammals are rare, except in the case of the pig, and the disease produced is usually limited and confined to the glands adjacent to the points of entry of the bacilli. This type of bacillus may however cause severe generalised and fatal disease in the pig, sheep, rabbit and marsupials.

The human bacillus has a narrower range of pathogenicity than either the bovine or the avian bacillus. This type can infect the pig, the calf and the

horse, but does not produce progressive tuberculosis in these species. It causes cutaneous tuberculosis in parrots and is one cause of tuberculosis in the dog and in various species of animals kept in captivity, namely the guinea-pig, monkey, gnu, antelope, peccary, etc., in which species infection is followed by generalisation and progression of the disease.

The evidence accumulated regarding the susceptibility of various species of animals to the three types of tubercle bacilli under farm and domestic conditions and in captivity may be summed up as follows.

All three types of bacilli can infect the ox, pig, horse, guinea-pig and rabbit.

Two types of bacilli have been found in the following species; viz. bovine and avian in the sheep, the goat and Australian marsupials; bovine and human in the domestic dog and in the ape, monkey and Ungulata in captivity; human and avian in the parrot.

Only one type of bacillus has so far been obtained from domestic fowls (the avian), the domestic cat, hedgehog, mink and ferret (the bovine) and members of several species in captivity.

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