

A Fatal Case of Streptotrichosis with Primary Lesion in the Lungs—the Organism Pathogenic for Animals.¹

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HISTORY.

A CARPET porter, aged 67, employed at a large store for twenty-seven years, was in fairly good health until five weeks before death, though his appetite had been failing for a fortnight previously. A sudden attack of pain of an aching character between the shoulders and at the lower part of the back caused him to take to his bed. In two or three days the abdomen began to swell, and the night before admission to hospital (two weeks after the onset) he coughed incessantly. He had wasted rapidly whilst in bed. Had had a slight cough, worse in the mornings, for four months. No history of pulmonary tuberculosis; bronchitis sixteen years before, with winter cough since; three years before had a bad illness with much wasting, but no night sweats, which lasted one month. Habits: Several pints of beer daily, with occasional exacerbations. Had been in the Army, but never abroad.

On admission the abdomen was distended, especially the upper part, with fluid; temperature, 98.6° F.; respiration, 24; pulse, 100; heart, *nil*; rhonchi and coarse râles over the lungs, posteriorly below the angle of the left scapula, a patch of dullness with blowing breathing. Urine *nil*. The temperature rose gradually with daily remissions during the first week to 101° F., and then to 102° F., and in the next week at times reached 103° F.; the respiration increased to 36, the pulse to 120, the cough became more troublesome, and he died nineteen days after admission and five weeks after the onset. A week before death 152 oz. of opalescent fluid were withdrawn from the peritoneal cavity. This was turbid, and unfortunately the routine examination only was performed, revealing leucocytes and epithelial cells; four days before death there were 12,400 leucocytes in the blood.

POST-MORTEM FINDINGS.

Body spare and wasted; some straw-coloured fluid in abdomen. Peritoneum everywhere covered with closely arranged minute granules

¹ From the Laboratories of the Westminster Hospital and the Brown Institution.

(size of ground rice), even in the pelvis. Abdominal viscera normal; spleen 8 oz., liver 64 oz., kidneys 6 oz. each. Pleuræ normal. Right lung 57 oz., in the lower lobe a mass of consolidation the size of an orange projecting slightly above the surface on the lateral aspect, where it appeared as an injected red area, mottled with white purulent foci. On section it was found to be honeycombed with small suppurating foci. Several smaller but similar areas were found in the same lobe, and a large area in the adjoining middle lobe together with several smaller areas and some minute spots of softening. Left lung, 16 oz., contained no such lesions. Both apices were shrunken and calcified, and everywhere throughout both lungs were small pigmented nodules due to chronic interstitial pneumonitis; mediastinal glands pigmented. Nothing further of note.

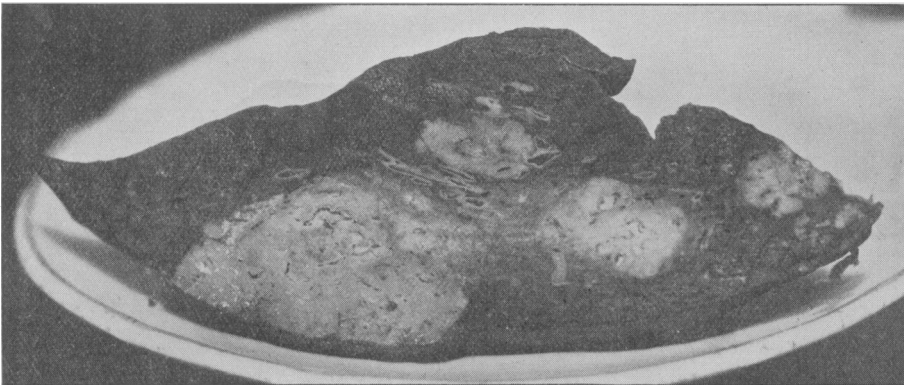


FIG. 1.

Section through lung.

The general appearances of the pulmonary lesions suggested actinomycosis, and a cursory examination of the pus revealed a Gram-positive and acid-fast streptothrix; consequently, various culture-media were inoculated with some of the contents of the deeper abscesses, and a further quantity was also sealed off in sterile pipettes for animal inoculation. This material from the cavities was thick, curdy, and white, and was drawn into the pipettes with difficulty. Next morning a guinea-pig and a rabbit were inoculated. Pure and prolific cultures were obtained in all the media and pathogenic effects produced in the animals. The details of these observations are given below:—

HISTOLOGY OF THE LESIONS.

Lung : In the consolidated areas are large collections of leucocytes, which have formed definite abscesses and increased in size by solution of the alveolar walls; the central parts are degenerating. The alveoli around these areas are filled with fibrin. In the less affected areas there is hyperæmia and the alveoli contain cells and fibrin, whilst further afield they contain some catarrhal cells in a patent lumen. In amongst the leucocytic infiltration numerous streptothrix filaments with branching portions are present.

Peritoneum and omentum : In these sections are found subperitoneal minute miliary tubercles with large central giant-cells, connective-tissue cells, &c., as found in the so-called typical histological tubercle due to *Bacillus tuberculosis*, from which it is impossible to distinguish the lesions. The giant-cells contain a great number of nuclei.

Sections stained with carbol-fuchsin and treated with acid and alcohol showed two or three deep-stained bacilli, an occasional one being found in a giant-cell; but, if anything, they were a little broader than *Bacillus tuberculosis*, though it must be recognized that it is impossible to differentiate between them. With Gram's method no filaments or any organisms could be found in the sections examined.

BACTERIAL FINDINGS.

Cultures were obtained on all the ordinary laboratory media under aerobic conditions only.

In *broth* a whitish surface growth had formed in twenty-four hours, and this in two weeks increased to a dense efflorescent growth, which adhered to the sides of the tube as a coherent membrane, for the most part thin and white, but in places finely nodular. The media remained clear, but portions of the surface growth had broken away and added to a slight layer of growth forming at the bottom of the tube.

In a flask of *bouillon* containing human blood, in a few days the surface was covered with a whitish membrane of growth.

On *potato* in a few days white, discrete, raised, hard colonies with a wavy margin and about the size of a pin's head, and in a few weeks this had increased to a white heaped-up mass of discrete colonies with irregular hard surface but with little tendency to spread widely. The surface was efflorescent.

On *agar-agar* a hard whitish growth slowly formed, resembling

actinomycosis, of discrete colonies, raised, hard and later heaped up, but never luxuriant.

On *glucose-agar*: a similar growth, but, early, in the condensation water there appeared discrete spheroidal white colonies which adhered to the sides of the tube on shaking.

In a *glucose-agar stab*: little growth in the depths but more towards the surface, over which it slowly spread with a wavy margin and heaped-up centre. In a *glucose-agar shake* there was no growth in the depths.

Blood-serum: as on agar, and no liquefaction.

Gelatin stab: a good growth spread over the surface, but diminished in amount along the track of the needle with lateral offshoots.

The characteristic surface growths on fluid media and the hard, discrete, raised growths on solid media were obtained in all subcultures, and also in cultures from the lesions in the experimental animals. On removing the surface growth from the bouillon flasks it showed no tendency to reform, growth proceeding in the depths whilst the media remained clear above.

All the cultures were strikingly white in colour, but an old potato growth has after some long time become faintly pinkish.

MORPHOLOGY OF THE STREPTOTRICHIX.

The most notable feature about the organism is its pleomorphism. It is only seen as a branching filamentous growth forming a mycelium in the tissues and original pus and in very young cultures, whilst in artificial media it rapidly tends to split up into spheroidal, spore-like bodies and to grow as short rods. The filaments in the tissues and pus of the lungs and in the abdomen of the guinea-pig were not homogeneous on staining with Gram's method—the only satisfactory method we could use—but presented a beaded appearance with intervening faintly-staining areas.

In cultures this beading is seen early, and in the surface growth on bouillon, potato, &c., the threads rapidly split up into spheroidal "spore"-like bodies, so that in about a week the predominating feature is the collection of these spores between a few filaments. Often these filaments are very scanty and very faintly staining, and a Klatsch preparation from the surface of a few-weeks-old potato-culture consisted almost entirely of spores and resembled a film of staphylococci. In the deeper parts of the potato growth and in the deposit in the bouillon

tubes fine moniliform threads occur, probably degeneration forms; and in the latter numerous short rods resembling bacilli, and short beaded filaments, but never any spores, which only appear to form in the surface growths. In old cultures involution forms are found in the shape of filaments with small bulbous swellings in and at the extremities. In the guinea-pig's pus many collections of spores were found amongst the beaded threads. In later subcultures, made after some length of time, no mycelium was obtained, but short branching threads and short rods,

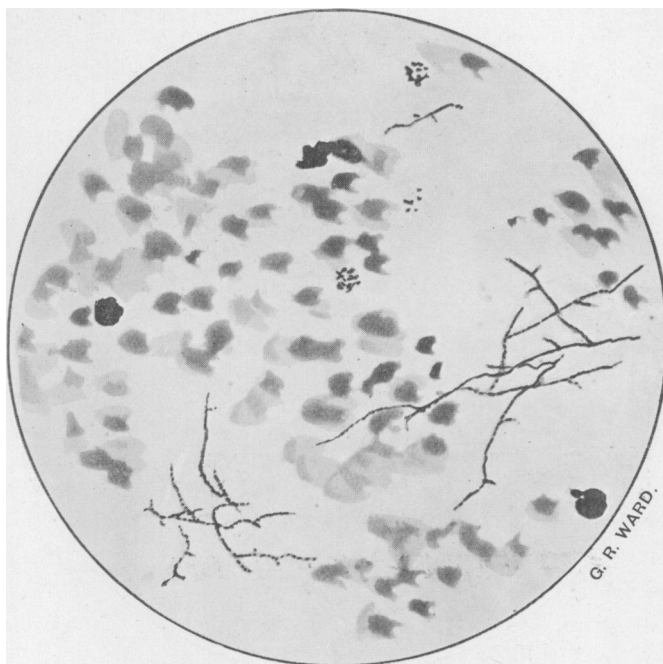


FIG. 2.

Streptothrix in pus, stained by Gram's method, showing beaded mycelium.

some beaded, formed the main portion of the growth, with but a few spores.

TINCTORIAL CHARACTERISTICS.

No satisfactory results could be obtained with Löffler's methylene blue, or with a modified Romanowsky, the latter producing only a granular appearance. Gram's method was most satisfactory. Ziehl-Neelson's method: In the original pus the filaments retained the stain

after treating with 25 per cent. sulphuric-acid methylene blue for five minutes or more, but even then they were not so deeply stained as tubercle bacilli. In the pus from the guinea-pig, after five minutes' treatment with this same stain, the spores remained red, but the filaments only partly so, and after one hour's treatment only the spores and some short rods remained red. In cultures the spores were more acid-fast than the rods or filaments, those in older specimens resisting the acid methylene blue for sometimes an hour.

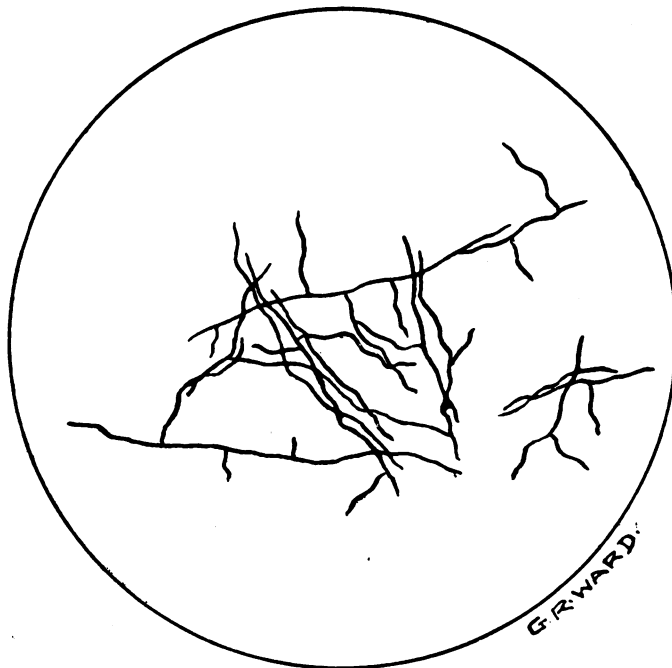


FIG. 3.

Sixteen hours' culture in broth from original pus.

RESISTANCE OF THE ORGANISM.

The organism remained alive in sealed-up tubes of pus for quite three months and cultures were then obtained, but experimentally it was not noted as virulent, though perhaps this may be ascribed to the fact that only a little was left for inoculation. In old broth-cultures also the virulence seemed diminished, though larger doses did produce pathogenic effects.

Thermal death point: Cultures containing many of the spore-like bodies were unaffected by a temperature of 60° C. for thirty minutes, but were readily killed at 80° C. for ten minutes.

EXPERIMENTAL RESULTS.

Guinea-pigs.—(1) An adult male animal received intraperitoneally about 1 c.c. of the contents of a caseating area in the lung on the morn-

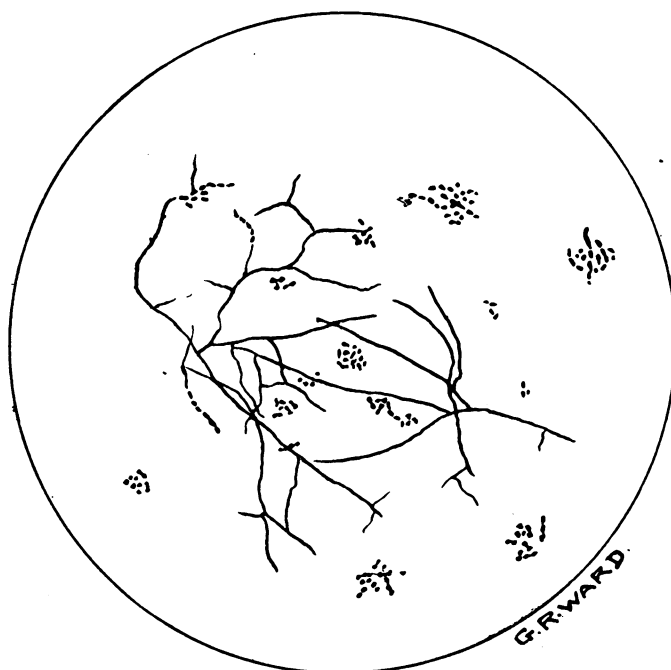


FIG. 4.

Seven days' culture in broth from original pus.

ing following the autopsy. The animal became acutely ill with a temperature of 105.6° F. next morning, rapidly wasted, and, as it appeared moribund, four days later was killed. A few miliary nodules were found on the peritoneum around the site of inoculation and some caseating nodules in the omentum about $\frac{3}{8}$ in. across. Pure cultures of the streptothrix corresponding to the original strain were obtained from the peritoneum and no other organisms. Histologically the miliary nodules

consisted of a subperitoneal cell-infiltration in which were some roundish areas made up of epithelioid cells—the arrangement recalling the miliary tubercle—but no giant-cells were found. In these and in the areas in the omentum the branching filaments described above were readily found.

(2) A second adult male guinea-pig received about 1 c.c. of a thick emulsion of the surface growth of a blood-bouillon flask three weeks later, and it also became acutely and rapidly ill, with a persistent temperature of 105° F. ; in five days it was much emaciated and the testicles

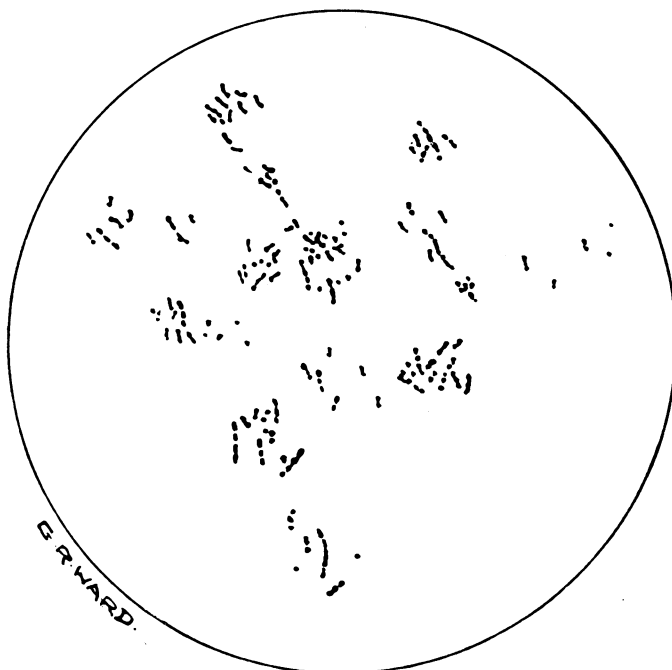


FIG. 5.

Ten days' culture in broth, showing disappearance of the filaments.

much swollen,¹ so it was killed next day. Nodules were found along the parietal peritoneum and a few scattered along the visceral membrane; a large caseating area on the under surface of the liver; fine nodules on

¹ It was at first thought that the lesions in the scrotum were due to *Bacillus mallei*, which was being used at the time for experimental purposes; but the possibility of the cultures having been confounded was put out of court by the subsequent experiments with repeated production of scrotal lesions. Hence this similarity of results is of great diagnostic import.

the gall-bladder and some caseating material united the layers of the tunicae vaginales, whilst the testicles were enlarged. Lungs and heart normal. The pus was white and caseous, and contained filaments and numerous acid-fast spore-like bodies in groups. The filaments showed marked beading as described.

(3) Another guinea-pig was inoculated with a smaller dose of an agar-culture a fortnight after this, but as it appeared well six days later a second dose of a broth-culture was given into the peritoneum. The animal behaved like the previous ones, and on the third day was apparently moribund, with very large testicles; but it remained in this condition for a few days and then slowly recovered, the testicular swelling subsiding. It was killed some weeks later and no lesions of any note found. The animal at one time was so ill and had emaciated so rapidly that it seemed impossible for it to recover.

(4) Later two animals were inoculated, the one intraperitoneally, the other subcutaneously, with some of the original pus that had been stored in sealed tubes for about ten weeks and from which the streptothrix was obtained (at the time of inoculation) in pure culture, but the animals remained well.

Rabbits.—A rabbit received about 0·75 c.c. of the original pus into an auricular vein, several punctures being made, and it was given a second dose a week later. The temperature was raised a little, but there were no marked general symptoms. Around the sites of inoculation several caseating nodules formed and increased to the size of an almond nut and burst. From the caseating contents of these the streptothrix was obtained in pure culture. The swellings slowly resorbed and only some fibrous nodules ultimately remained. The temperature remained at about 103·6° F. for some weeks, and the animal lost a little in weight, which was the more striking as it was not full-grown. It was killed in about two months and there was found nothing but some scattered miliary nodules in the lungs. These, histologically, were mostly degenerate and structureless and surrounded by fibrous tissue, but some consisted of round-cells and epithelioid-cells, amongst which no giant-cells could be found nor any micro-organisms. Evidently, whatever lesions had resulted from the inoculations were rapidly being removed.

(2) Another rabbit recently received 0·75 c.c. of a thick emulsion of a very old subculture into the auricular vein. It rapidly became very ill and died in fifty-four hours. The lungs and pleura were intensely inflamed, and scattered throughout the lungs and kidneys were numerous pin-point white areas. The organism grew with great

rapidity in the tissues, and microsections of the lungs and kidneys showed a *prolific mycelium growing from the surface of the pleura*, in the lungs and in the kidneys, forming a most striking picture.

(3) Another rabbit received 0.75 c.c. of an emulsion of a recent sub-culture, intraperitoneally. The temperature varied between 102° F. and 104° F., but there was no loss of appetite or marked general symptoms. It was killed in two weeks, and there were found caseous nodules on the mesentery and omentum, some the size of a small nut, and a few miliary nodules on the surface of the liver and on the mesentery. In none of these nodules were there any giant-cells found, but merely round-cells, central degeneration, and peripheral encapsulation; filaments of streptothrix were found.

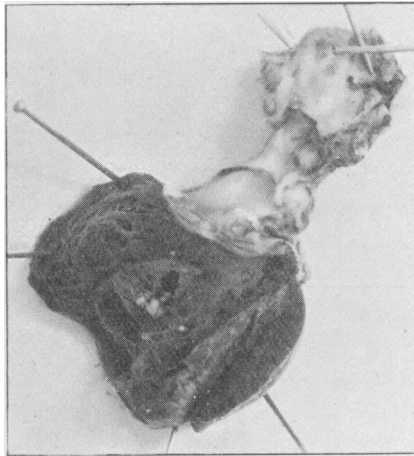


FIG. 6.

Heart of rabbit opened to show the white vegetation on the tricuspid valve. Two smaller ones on the chordæ tendineæ; the top of the larger vegetation is blood-stained and therefore indistinct. (The specimen is preserved in the Westminster Hospital Museum, No. 659.)

(4) Another rabbit received on the same date as (3) 0.75 c.c. of the same culture into an auricular vein. No ill-health followed, but the temperature varied between 105° F. and 103° F., though caseating, pea-size nodules appeared at the site of inoculation. It was killed in three weeks and presented interesting appearances as follows: Recent pleurisy; on the right side the diaphragm was adherent to the pleura by means of a thickish, organizing, gelatinous exudate. Discrete miliary, caseous

nodules scattered throughout the lungs. In the heart was found a *large white vegetation*, pendulous and about $\frac{3}{8}$ in. long, attached to the tricuspid valve, and, near by, two minute vegetations of the same nature on the chordæ tendineæ (fig. 6). Miliary nodules in the kidney. The right epididymis was swollen and caseous, and from the pus streptothrix was obtained.

Mice.—Repeated inoculations, intraperitoneally and subcutaneously, into mice produced no results.

SUMMARY.

A man died of an acute suppurative pneumonitis affecting one lung, together with a granulomatous peritonitis. From the abscesses a streptothrix (branching, beaded and pleomorphic) was isolated. This grew well on artificial media, producing a characteristic white surface growth on bouillon, was Gram-positive and to a certain extent acid-fast, the spore-like bodies, which were also a characteristic feature, being the more acid-fast. It was pathogenic to guinea-pig and rabbits, but more so in the former, and not at all to mice. It was found in the tissues and in cultures from the lesions of the lung of the man and the lesions in the animals. These lesions consisted of abscesses and caseating nodules, which resorbed, and in the guinea-pig minute miliary nodules on the peritoneum. In the guinea-pig enlargement of the testicles was a peculiar feature. It is difficult to say definitely what the miliary granulomata on the peritoneum of the patient were. As nothing but an acid-fast bacillus was found in them, and as this would do for a tubercle bacillus or a streptothrix, and more suggestively for the former, the question cannot be decided until similar lesions are produced experimentally by this streptothrix. In the nodules produced on the peritoneum of the guinea-pig no giant-cells were found, but otherwise they resembled the human lesions. Further, Stuart McDonald [4], working with an organism resembling in most points this here described, produced in rabbits, on intraperitoneal inoculation, in three weeks disseminated nodules in the lungs containing giant-cells. Flexner [2] also, with a different streptothrix, produced, experimentally, nodules with giant-cells corresponding to those in tuberculosis.

The mode of infection in this case was not evident. The man was a carpet porter and spent much of his time in cutting up cocoanut matting, but it seemed impossible to attempt to isolate a streptothrix from this source. Streptotrichosis is far from uncommon, and numerous

cases are on record of infections in all parts of the body—the thorax, abdomen, brain, external parts, and generalized infections.

The literature has reached enormous proportions, and in a recent publication [5] an exhaustive bibliography includes references to over 1,500 papers on the subject. In this country Foulerton [3] and Dean [1] have treated the subject at length, and the former has attempted a classification on a biological basis. Of the many varieties that are known, it seems probable that those pathogenic to man can be included in a few broad groups. The organism described in this paper is in most respects similar to that described by Eppinger, and ought to be classified with it.

The specimens are preserved in the museums of the Westminster Hospital Medical School and the Royal College of Surgeons.

For permission to make use of the clinical notes I am indebted to Dr. Murrell.

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