THESIS

on

THE DISSEMINATION OF DISEASE-PRODUCING MICRO-ORGANISMS BY SPUTA.

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Micro-organisms are a distinct class of unicellular vegetable organisms placed under the general name of bacteria instead of trying to affix either algae or fungi to this class of living beings. These micro-organisms are divided into two classes; pathogenic and non-pathogenic bacteria. The pathogenesis is determined by inoculating a susceptible animal with the germ, and recovering it from the infected animal. The non-pathogenic bacteria need but little consideration here, since harmful results do not follow their presence.

The spherical bacteria, or micro-cocci, differ greatly in size and also in the mode of classification, when as a result of binary division, they remain associated one with the other.

The elongated bacteria classed as bacilli multiply by binary division, transverse to the longitudinal axis and in consequence long chains quite frequently occur. In other cases the rods are solitary and in pairs. As the cocci, so also the bacilli, may be surrounded by a capsule. Bacilli under certain conditions may appear as short rods, as for example in tuberculosis. The greater activity of growth is indicated by the growth of short bacilli, while under other conditions they may grow out into long filaments.
These bacteria are measured by the standard of measurement, which is the microm (or the one-thousandths part of a millimeter). This is equal to about one-twenty-five thousandths of an English inch. Some of the smallest micro-cocci may measure not more than 0.1 microm, while some of the largest species are from one to two microms in diameter. The large number of these minute organisms which could occupy the space of a drop of water may be estimated as many millions. It is readily perceptible by the above statement that with the unaided eye the presence of these organisms cannot be perceived. Take for example one of the smallest micro-cocci having a diameter of one-twenty-five-thousandth of an inch, then to cover the diameter of a sphere one-twenty-fifth of an inch it would require 25 thousand organisms. As with plants of larger dimensions, we note a great variance in size of these organisms. This may only be detected by the aid of a microscope and a series of experiments whereby the color and growth on different classes of media, aided in the case of virulent types by the pathological effects on a variety of susceptible animals. The pathogenic properties serve to prove the presence of certain germs, and in times of doubt, the absence of the germ may be ascertained since the characteristics of the disease are known. When in active growth the cocci deviates from the spherical forms and at the time of division they may be greatly elongated.
However, there are always some of the spherical forms present in the culture since environments do not affect all alike. In accordance with the modes of reproduction, terms are applied thus; if they remain adhering together they are designated as diplo-cocci, or strepto-cocci, according as they occur in pairs or chains.

In old cultures we find greater exhibition of more irregularity in form due to the constrictions.

The morphological variations of the different tubercle bacilli distinguish the various types or species. As for example; the human, bovine, and avian types vary morphologically yet they all bear general characteristics of the tubercle bacilli. Among the bacteria, as in cells of higher plants and animals, the peculiar biological characteristics of a species are transmitted to its descendants. It has been asserted that these vegetable cells are destitute of a nucleus, but recent bacteriologists suggest that a nucleus may occur. The presence of spores in bacteria is ascertained by special processes of staining. In staining quickly, it often happens that a portion of the protoplasm is sharply differentiated by taking the stain more deeply than the remaining portion. The remarkable fact has been established that tubercle bacilli in the dead condition when introduced into the tissues of a susceptible animal in sufficient number can produce tubercle-like nodules, due to the action of their toxins. The subject has been very fully investigated with confirm
matory results and it has been found that if the number of bacilli introduced into the circulation is large there results very numerous tubercle nodules with well formed cells and also by occasional caseations. These bacilli may be recognized in the nodules by the regular staining method.

When the living organism gains access to the susceptible animal body, fatal results occur. The most common means of entering the body is the respiratory tract. Consequently pulmonary tuberculosis is the most common form affecting man. The tubercle bacilli gain access to the respiratory tract from the air which contains the organism suspended in a dessicated state. Since dust particles remain in suspension in the air, it is reasonable that these germs which are so infinitely smaller than dust particles, also remain in suspension when in the dessicated state. While children acquire tuberculosis more frequently from the infected milk of cows, yet the source of infection which the people of the land must learn to guard against is that of allowing patients to expectorate on floors, walls, and side-walks because upon becoming dessicated the air is immediately polluted, with these germs by physical, mechanical, and natural disturbances. The organic food required for the nourishment of these bacteria is only found in the living body. Their presence in the air is due to the fact that they are raised from the surfaces from which they exist in
a dried form and since they are so light they may be carried to distant places. When not exposed to currents of air they fall again on exposed surfaces just as dust particles precipitate in the absence of currents of air. If this surface upon which they subside be moist they are detained but if it is dry they are again carried by the following current of air. More bacteria are thus found near the surface than at some distance above the earth, more over the land than over the sea, more in the cities with their dust covered streets, than in the country with its grassy fields. Experiments have proven that bacteria do not appear in the atmosphere from liquids unless portions of the liquids containing them are projected in the air by some mechanical means; as the bursting of bubbles of gas. Cultures of pathogenic bacteria freely exposed to the air do not endanger the health of those who work over them, but if such a culture be carelessly allowed to fall on the floor, remaining without disinfection, when it loses its moisture, the bacteria contained in it will form part of the dust of the room becoming dangerous to its occupants. Bacteria from the ejected excretions of the mouth and nostrils thus become disseminated through dessication. Bacteria and their spores float in the air we breathe, swim in our drinking water, and develop upon the food we eat. They enter the nose, and the mouth is always filled with them, since the saliva
is alkaline in reaction, thus promoting their growth. And since we swallow many the digestive tract also contains these organisms. Wherever living organisms live, die, and decompose there are sure to be several varieties of bacteria, and since the mouth and respiratory tract seem to be the home of a great number of types, the organs of the body are the home of many pathogenic and non-pathogenic varieties. Infection with some is afforded by the nares of the body, but more readily through inhalation of foul atmosphere. Considering tuberculosis human, bovine, and avian, insight will be granted as regards the ease of transmission from one being or animal to another of different species. In the avian a source of infection is offered through the digestive tract. The bovine type may be contracted by the use of cow's milk. Tubercule bacilli have been grown on vegetable media to a certain extent, yet the greatest multiplying area is the animal body and the only extensive means by which the disease is spread seems to be by tubercular tissues, and secretion containing in the bacilli. The tubercule bacilli leave the body in large numbers in the sputa of tuberculous patients, and when the sputum becomes dry and pulverised the highly resistant bacilli, retains its vitality. The air containing these bacilli is taken into the lungs by inhalation. As the air advances along the respiratory tract, deposition of the tubercle bacilli occurs on the
walls as the air is deflected from side to side. Should they be retained in this favorable locality for a short period, reproduction would commence, and since by experiment it has been proven that the tubercle bacilli have the power of transmission from one part of the body to another, we can readily see that the bacilli may easily gain entrance to the lungs where it will produce fatal results. Inhalation and ingestion are therefore the two main sources of infection of tuberculosis in the animal body. Not only by inhalation but also by ingestion tubercle bacilli may be retained at the pharynx. The tubercle bacilli may be few in number and difficult to locate as seen in the drawings of specimens which will follow as viewed through the microscope, while again they may be present in great numbers. There are very few in number in chronic lesions regardless as to whether they are tubercle nodules with connective tissue developed or old caseous collections. The bacilli are most plentiful in the acute lesions. They are to be found in the free state most commonly. In the sputa of tuberculous patients their presence is easily demonstrated at a certain time. Several examinations are sometimes necessary to detect their presence.

The saliva of healthy persons which seems to be the normal habitat of pneumo-cocci is not as apt to endanger those who are forced to breathe air containing
this saliva in dessicated form, as when expectorated by a patient suffering from pneumonia. Thus we find that the expectoration from our brothers may contain either tubercle bacilli, the greatest and most to be feared or the secondary, which is the pneumo-cooci.

We find by statistics that the ratio of small pox to tuberculosis is as one is to sixty-four (1:64). Realizing this fact, why not fear tuberculosis more than we now fear smallpox? Small-pox can be contracted by being in the presence of the patient, while tuberculosis can only be acquired through unsanitary relations.

Bearing in mind a few pre-requisites we may not necessarily be forced to place our friend in isolation. With proper disposal of excretions from tuberculous patients as well as proper disinfection of the attendants and rooms, dissemination of the disease need not be feared so much. These pre-requisites include the selection of proper containers for the excretions of patients together with a thorough disposal and disinfection of the same. The salivary and nasal secretions are best received in pieces of cloth which may be burned after use. However, if handkerchiefs be used, subsequent thorough boiling and exposure to suitable disinfectants must be applied. Towels, napkins, knives, forks, spoons, and plates may be easily retained to themselves in order that a thorough disinfection may follow, lengthy per-
iods of boiling usually sufficing to destroy the vitality of both tuberole bacilli and pneumo-coobi as also other pathogenic forms.

After the patient has recovered from the disease, he should not associate with people until his body and clothing have undergone a thorough disinfection. The apartments must also receive disinfection. Great care should be taken in caring for the sick and arranging a degree of cleanliness after recovery. All articles of apparel that can be disposed of should be burned, otherwise the application of some good disinfection must be employed. Boiling of clothing for half an hour is quite efficient. Where possible, exposure to steam and dry heat at 110° C. for two hours is sufficient. As to the patient, the hands and general surfaces of the body should be washed with chlorinated soda (1 part to ten parts of water); carbolic acid (one part in fifty); corrosive mercuric chloride (one in one-thousand parts); or thymol (one in twelve hundred parts).

Should death occur, the body should be wrapped with a sheet saturated with mercuric chloride corrosive (1 part in 500 parts water), or carbolic acid (1 part in 20). Boiling water containing a 10% solution of ferrous sulphate or zinc chloride may be counted as effective in destroying all pathogenic bacteria if subjected to periods of from one to two hours.

The following experiments were performed:
THE TUBERCULAR TEST.

The specimen is stained with carbol-fuchsin and method. counterstained by Gabbett's. If tubercle bacilli be present they will have a scarlet red outline.

No.1. Sputum was obtained from the floor of the building. No tubercle bacilli present, but round bright yellow colonies with somewhat lighter borders. Proven to be micro-coccus pyogenes aureus.
No. 2.

Expectoration on floor shown no tubercle bacilli by the tubercle bacilli test, while Strepto-coccus pyogenes albus was present.
No. 3.

Sputum from expectoration in container shows no reaction for tubercle bacilli, yet however micrococci pyogenes albus was present.
No. 4.

Sputum revealing tubercle bacilli by the test.

The blue spots in this and the following drawings represents pus cells.
No. 44

This is the tubercle bacilli recovered after having inoculated and dissected a healthy guinea pig which was inoculated with the tubercle bacilli found in No. 4.
No. 4.

Stained with carbol-fuchsin, and treated with Gabbett's Counterstain, revealed quite a number of elongated tubercle bacilli. From this a normal guineapig was inoculated subcutaneously with sputum mixed with one cc bouillon. Within 2 weeks local abscess appeared at the point of inoculation: swelling behind fore legs. It was of a tuberculous nature. The discharge from the suppurative abscess contained T.B. The pig gradually wastes away, dying at the end of two months.

POSTMORTEM EXAMINATION.

Glands in the groin bear T.B. intense hemorrhages. The abdominal cavity is filled with clotted blood of a very dark character. Spleen very much enlarged and quite friable. The hemorrhage was from the spleen, and hence final cause of the death. The liver was very large, and of a pale, grayish yellow color. It was somewhat mottled, yet no tubercles were present. Gall bladder normal. The mesenteric glands showed one tubercle. The Kidneys expressed normality except adhesions. Heart collapsed; the left Auricle being much reduced in size. The lungs showed soft tubercles in their incipiency at apex. The internal viscera exhibited adhesion to the walls. There were two large and several small tubercles on the
thoracic wall. At the point of inoculation there was a large suppurative abscess, which had removed the hair, leaving a thickened abdominal wall.

No. 5.

Sputum from floor contained no tubercle bacilli, but a minute micro-cocci was present.
No. 6.

Sputum from container, showed no evidence of tubercular colonies on glycerine-agar plates, nor growth in gelatine stab culture. There were small transparent drop-like colonies. They were small bacilli, solitary or united in chains. Hence bacillus of Influenza.
No. 7.

Specimen from the floor. Stained with carbol-Fuchsin, Counterstained by Gabbett's, revealed tubercle bacilli red in outline, as shown in drawing. Short thick with an occasional elongated bacilli. A guinea pig inoculated subcutaneously from sputum soon had local swellings—later abscess at point of inoculation. A gradual loss of flesh was the result of the inoculation. Hearty appetite, until death. At the time of death tubercles were to be found all over the body. It lived almost four months. The last two months breathing was in difficult; emaciation general. The pig was too badly infected to justify post-mortem examination.
No. 7.

Sputum revealing tubercle bacilli by the test.
No 8.

Sample from expectoration in a container. Tubercle bacilli were located by the carbol-fuchsin test. They were rods with rounded ends appearing both solitary and in chains. All were quite short some being slightly bent. A male guinea-pig of perfect health was inoculated with this tuberculous sputum. After 3½ months he had acquired a weakened condition. After death post-mortem examination was held. Suppurative abscess at the point of inoculation, was noticed. Intense adhesion of the tissue at the point of inoculation. All of the lymphatic glands were greatly enlarged and of a suppurative nature. Those in front of the hind legs were very large and hard. The salivary glands were greatly enlarged. The spleen bore many tubercles. The gall Bladder had tubercles on its tip. The lungs were dotted with necrosed areas. The intestines and mesentery were all normal.

This is the last Guinea pig that was inoculated, since it was by this time proven that sputum from these people of tuberculous nature was infectuous. Hence sputum sputa from all tuberculous patients may disseminate the disease.
No. 8.

Sputum revealing tubercle bacilli by the test.
No. 9.

Tubercle bacilli—Rods of varying length, for most part they are solitary as will be seen in the drawing.
No. 9.

Sputum revealing tubercle bacilli by the test.
No 10.

Carbol-fuchsin test revealed no tubercle bacille although many pus cells were present, characterised by the presence of tenacious membranes.
No 11.

Specimen from sputum in container revealed no tubercle bacilli by the test. A superabundance of micrococci were present. These produce the tenacious membranes found so frequently in specimens of sputum.
No. 11.

This drawing shows a stringy and viscid membrane caused by the cocci which is shown in the drawing. Test shows no tubercle bacilli.
No 12.

Sputum from sick person proven to be tuberculous. The bacilli are of varying lengths, some short and even appearing in chains.
No. 12.

Sputum revealing tubercle bacilli by the test.
No 13.

Sputum from infected person... No tubercle bacilli were present. The tubercle bacilli were short appearing in chains.
No. 13.

Sputum revealing tubercle bacilli by the test.
Sputum from patients who were continually expectorating tenacious sputum. No tubercle bacilli were present, yet many pus cells were to be seen.
No 16.

Sputum from individual who was in a depleted state of health. Carbol-fuchsin test presented no tubercle bacilli, however many yeasts and pus cells are present.
No. 17.

The sputum from a patient found to contain many tubercle bacilli which were about twice as long as broad. An occasional short chain appeared as will be seen by the drawing.
No. 17.

Sputum treated with tubercle bacilli test. Tubercle bacilli as well as tenacious membrane are present.
No. 18.

Specimen of sputum from an apparently healthy individual contained tubercle bacilli as well as pus cells. The bacilli were long and of the spotted type.
No. 18.

Sputum revealing tubercle bacilli by the test.
No. 19.

Sputum from expectoration on floor contain many cocci both solitary and in streptoc form, accompanied by masses of tought membranes.
No. 29.

Sputum from a container revealed a great number of cocci accompanied by tenacious membrane. An agar plate made from one drop diluted with a hundred cc's of water produced colonies too numerous to count. This is the cocci that has been found in almost every specimen and not only being the apparent cause of tenacious membranes found, it seems to be present in cases where tubercle bacilli are found. From this reasoning it seems evident that the tubercle bacilli are present in the sputum only when destruction of the tissues occurs.

No. 14 and 15 contained these cocci previously mentioned. This specimen was obtained from a person suffering with a tenacious exudate from the throat and lungs. Since the tubercle bacilli tend to form nodule-like tubercles surrounded by tissues, their presence in tubercular the sputa can only be positive when the tissues surrounding these nodules is being destroyed. Hence dissemination when of the tubercle bacilli can only occur if this cocci or other organisms capable of destroying tissue is present.

Conclusion.

Having thus examined the various samples of sputa, as they came from the mouths of our associates, is it not right that we accept a more scrutinizing observance of the possible spread of the various diseases that may
be disseminated by our expectorations, when they become
dessicated and form part of the impurities of the
air, which should be our purest and noblest friend? Our
articles of food are selected and prepared with the ut-
most observance of sanitary conditions, yet since we are
unable to see our close foes, the public persists in using
sidewalks, floors, and walls as receptacles for ex-
pectoration. By strict observance of sanitation, as
our various disinfectants afford, the parasites of
harmful nature may be avoided.

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