

paramitoma of the liver cells the following anaplastic and kataplastic products may be demonstrated easily:—serous fluid (vacuoles) bile pigment, pigment containing iron, glycogen, fat, &c.

[It is to be remembered that, soon after the discovery of lobules in the pig's liver by Wepfer (1664), Malpighi (1666) described these lobules as being appended to the extremities of the vessels contained in Glisson's capsule. Ferrein (1749) showed that the liver, like other glands of the body, had a tubular structure; but, as he included the spleen among the tubular glands, it may be doubted whether he did more than generalise on the basis of his observations on the kidney. Three years before the publication of Kiernan's paper, Müller seems to have noticed the pinnate arrangement to which I have given the name of "portal lines of divergence;" but there can be little doubt as to the general acceptance of Kiernan's views after the publication of his observations in 1833 ('Philosophical Transactions'). The work of Kiernan was in great part based on the result of injections through the vessels.

For an account of the history of the subject, I would refer the reader to Kiernan's admirable paper, in which a great many points which I have purposely left aside will be also found mentioned.—Dec. 17, 1890.]

IV. "On certain Conditions that modify the Virulence of the Bacillus of Tubercle." By ARTHUR RANSOME, M.D., F.R.S. Received November 29, 1890.

It is acknowledged by most pathologists that tubercular sputum, dried up and broken into dust, is the most common vehicle by which the bacillus of tubercle is conveyed into the body.

But its power for evil is obviously modified by a multitude of conditions, some of them inherent in the animal body exposed to infection, others due to external influences. Judging from the facts relating to the distribution of tubercular disease, its incidence in certain localities, and especially its prevalence in badly drained, badly ventilated, and imperfectly lighted dwellings, it has been surmised that the three chief external conditions that mitigate the virulence of the bacillus are: (1) a dry soil (2) abundance of fresh air, and (3) light.

But hitherto, few, if any, direct experiments have been made to determine the extent to which these several influences possess mitigating powers.

It is true that Dr. Candler, in his work on the Prevention of Consumption, affirms that light is the chief agent in destroying the

bacillary virus, and Professor Koch, in his address to the International Congress at Berlin this year, lends the weight of his great authority to the same opinion; but, in neither case, is any proof given of the truth of this view.*

It was in order to test the influence of light, air, and dry soils upon the virulence of the bacillus of tubercle that the following series of experiments were devised.

It was decided to expose tuberculous sputum :—

(a) In a locality (Bowdon) where the soil was dry and sandy (about 100 feet in thickness) and where very few cases of phthisis were known to have originated. It was to be placed in full daylight or sunlight, and exposed to abundant streams of fresh country air.

(b) A portion of the same sputum would be exposed under similar conditions, in the same place, with the exception that it would be put into a darkened chamber.

(c) A third portion would be taken to a small four-roomed tenement in Manchester, on a clay soil, without cellarage—and badly ventilated, but it would be placed on the window ledge, with as much light as could there be obtained.

(d) A portion would be placed in the same cottage, but in a dark corner of a sleeping room in which it was known that three deaths from phthisis had occurred within the space of six or seven years.

(e) Finally, a portion would be exposed to used air coming from a ward in a Consumption Hospital, in Bowdon, in darkness. These intentions were fully carried out.

Two collections of sputum were obtained :—

A. From a woman dying of phthisis, collected on April 25. This specimen contained comparatively few bacilli.

B. Also from a woman in an advanced stage of phthisis, collected on April 27. This sputum contained abundance of bacilli.

Sputum (A) was not considered to be very suitable for the purpose owing to the sparseness of bacilli; but it was decided to use it by way of control experiment; owing to an accident, the portions exposed under conditions (c) and (d) were lost.

These collections of sputum were divided into portions and placed in watch glasses marked A. 1, A. 2, A. 3, B. 1, . . . , B 10. Some of these watch glasses were exposed without further arrangement, but others, where there might be a possibility of infection, were enclosed in cages, so arranged that air could reach them through a

* [Since this was written, I have learnt that Savitzky has ascertained that phthical sputum, exposed "at the ordinary room temperature, and generally under all common life conditions," retains its infectiousness not longer than $2\frac{1}{2}$ months, and, other conditions being equal, a sputum dried in darkness loses its infectious properties within the same period as a sputum exposed to light. 'Med. Chronicle,' Nov. 1890, p. 117.]

thin layer of cotton wool, one kind of cage being constructed of two squares of glass, supported at their edges by cork, and surrounded by cotton wool, the other of small flasks the bottom of which had been cut off, and the lower edge resting in a small circular tray fitted with wool, the mouths of the flasks being also loosely stuffed with the wool.

These watch glasses were then exposed for five weeks under the conditions already noted, commencing on April 29, 1890, with the exception of B. 9 and 10, which were started on May 2. Most of the specimens were withdrawn on June 3; but one, B. 10, was divided on May 13, and a portion, B. 10a, was introduced into a glass bulb and exposed for several minutes each day to a current of ozonised oxygen.

All the specimens were then enclosed in a box and forwarded to the Pathological Laboratory, Owens College, where Dr. Dreschfeld, the Professor of Pathology, had kindly undertaken to carry out the necessary inoculations. Owing to various causes, some of these operations were not commenced until June 27, 1890, others until July 10. The animals used were rabbits, kept under favourable hygienic conditions. The dried sputum was mixed with sterilised water, to form a pasty mass, and this was inserted into the subcutaneous tissue of the back. All the instruments used were made thoroughly aseptic.

The following tables give :—

- (1) The conditions of exposure.
- (2) The date of inoculation.
- (3) The date of death, by killing or otherwise.
- (4) Dr. Dreschfeld's report upon the results of the inoculation.

Table I.—Influence of Dry Soil, Air, and Light.

No. of specimen.	Conditions of exposure.	Date of		Dr. Dreschfeld's reports.
		Inoculation.	Death.	
A. 1	In outdoor studio, Bowdon. In light and free ventilation in flask arrangement	June 27	Killed Sept. 4	Rabbit in good condition; wound completely healed, cicatrix of wound scarcely visible. All inserted sputum completely disappeared, only a few pigmented streaks left, no caseation; internal organs healthy.
A. 2	Ditto, open watch-glass	July 10	Killed Sept. 4	In good condition; wound healed, good cicatrix, no caseous mass. In liver a number of disseminated firm spots; microscopically, these consisted of fibrous tissue; no tubercle bacilli found in them.
B. 6	Ditto in cotton wool cage	July 10	Killed Sept. 4	In good condition; cicatrix healed, no trace of sputum left, no caseation where sputum had been inoculated, only a few pigmented streaks.
B. 7	Ditto in open cage until May 9, then cotton wool added	July 10	Killed Sept. 4	Good condition; cicatrix perfect, some fibrous induration in subcutaneous tissue where sputum had been; no caseation; internal organs healthy.

Table II.—Influence of Dry Soil, Air, and Darkness.

No. of specimen.	Conditions of exposure.	Date of		Dr. Dreschfeld's reports.
		Inoculation.	Death.	
A. 3	In darkened photographic room, Bowdon, in watch-glass	June 27	Killed Sept. 4	Rabbit in good condition, small caseous mass beneath healed wound; all internal organs healthy. Microscopic examination of caseous mass.—Granular detritus, no tubercle bacilli.
B. 8	Ditto in cotton wool cage	June 27	Died Aug. 26	Moderately emaciated; wound healed, but the edges separated on pulling the skin at the sides. In the subcutaneous tissue beneath the wound a few yellowish, soft spots, about the size of pin-heads, surrounded by a zone of hyperæmia. Internally all organs healthy, no signs of tubercle, right heart full of blood, left heart empty. Microscopic examination of the yellow spots shows them to consist of granular detritus and a few granule cells; no tubercle bacilli could be detected.
B. 9	Under ward of Consumptive Hospital in full ventilation, in darkness, in cotton wool cage	July 10	Died Aug. 14	Emaciated; wound healed under a scab, a thin mass of yellow caseous material just beneath the skin. Heart and lungs healthy; kidneys contained a number of small cysts. In the caseous mass <i>a few tubercle bacilli were found.</i>

Table III.—Influence of Clay Soil, Bad Air, and Light.

No. of specimen.	Conditions of exposure.	Date of		Dr. Dreschfeld's reports.
		Inoculation.	Death.	
B. 3	On window-sill of small cottage bedroom in Ancoats. Flask arrangement	June 27	Died Aug. 14	Large rabbit; emaciated. Inoculation wound completely healed, slight scab; no caseous material or any signs of sputum. Internal organs healthy; one white spot found on surface of liver. Microscopic examination of this showed it to consist of round cells, some with one nucleus and others which were polynuclear. At the periphery of the nodule, fibrous tissue. Sections of the nodule showed no tubercle bacilli.
B. 4	Ditto in open watch-glass	July 10	Died Aug. 9	Emaciated, wound at back not healed, and appeared slightly sloughing at the borders. Lungs presented several small caseous nodules; pleura, heart, peritoneum, liver healthy. <i>Tubercle bacilli</i> found in the caseous lung nodules.

Table IV.—Influence of Clay Soil, Bad Air, and Darkness.

No. of specimen.	Conditions of exposure.	Date of		Dr. Dreschfeld's reports.
		Inoculation.	Death.	
B. 1	On dark shelf by fire-place in small cottage bedroom in Ancoats. Flask arrangement	June 27	Killed Sept. 4	Rabbit in good condition; wound completely healed, no caseation, and only a small pigmented spot where the sputum had been deposited; all the internal organs healthy.
B. 5	Ditto in a dark corner near the bed. In watch-glass	July 10	Killed Sept. 4	Rabbit in good condition; cicatrix where the wound was, and beneath it a caseous mass about the size of a bean. Examined microscopically, this mass contained <i>tubercle bacilli</i> . Nothing abnormal in any of the organs.

Table V.—Influence of Dry Soil, Bad Air, and Darkness.

No. of specimen.	Conditions of exposure.	Date of		Dr. Dreschfeld's reports.
		Inoculation.	Death.	
B. 10	Cotton wool cage, in ventilating shaft from ward of Consumption Hospital for ten days, then placed on top of bookcase in sitting-room	July 10	Died Aug. 14	Emaciated; wound healed under a scab. A yellow caseous mass about the size of a small pea beneath the scab. The liver presented a few yellowish nodules; all the other organs sound. In the caseous mass a <i>few tubercle bacilli were found</i> ; none in the liver.
B. 10	A portion of the above was taken on the tenth day and exposed to a current of ozonised oxygen for a few minutes daily for a fortnight	July 10	Killed Sept. 4	Rabbit fairly well nourished; cicatrix quite healed, no trace of inoculated matter, and no trace of caseation. In the left lung one firm nodule; this was carefully examined microscopically and showed no bacilli. It was apparently only thickened pleura.

It will be seen that none of the four specimens of sputum exposed to fresh air and light on a dry soil conveyed the disease, but one of the three portions exposed under similar conditions in darkness produced tubercle.

Of the two exposed in the cottage in Ancoats in the light one produced tubercle, and of the two specimens exposed in the same place, in comparative darkness, one caused tubercle, the other did not.

Lastly, the specimen placed in the ventilating shaft from a ward in the Consumption Hospital, Bowdon, on a dry soil, conveyed the disease, and the portion removed from it after ten days and exposed to the action of ozonised oxygen did not produce tubercle.

These experiments are too few in number to justify the statement of positive conclusions, but, so far as they extend, they go to prove that fresh air and light and a dry sandy soil have a distinct influence in arresting the virulence of the tubercle bacillus; that darkness somewhat interferes with this disinfectant action; but that the mere exposure to light in otherwise bad sanitary conditions does not destroy the virus. There are also some indications that the presence of a cotton wool envelope may interfere somewhat with the action for good or evil of both good and bad air respectively.

Further observations are now being made with sputum exposed by Professor Tyndall at Bel Alp, Switzerland, in light and darkness, each kind for 10 days and 14 days respectively, and compared with the same sputum exposed in the same cottage in Ancoats.

The pathological results of these specimens have not yet been made out. The results will be given in a future note.

The Society adjourned over the Christmas Recess to Thursday, January 8th, 1891.

Presents, December 18, 1890.

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