CAUSES OF THE PREVALENCE OF PULMONARY TUBERCULOSIS IN SOUTH-EAST CHINA.

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Before considering some of the more potent predisposing causes of pulmonary tuberculosis one must devote a few paragraphs to the support of the opinion assumed in the title of this article—one must give grounds for answering in the affirmative the question "Is tuberculosis common in South-East China?" Unfortunately it is not possible to adduce statistical evidence in support of an affirmative answer, and this absence of exact figures depends on causes which not only hamper our work, but also seriously conceal the vastness and urgency of the problem, namely, the absence of (a) death registration, and (b) post-mortem examinations in cases where the cause of death is not obvious.

If one tries to get light on this question by considering the records of the only place in South China where vital statistics are collected one again meets with difficulties, for deaths from chronic illnesses are relatively rarer there than elsewhere, on account of the desire of the Chinaman, when death is impending, to return to his ancestral home—usually in some distant village in China proper—so that no mention of his death is found in the records of the British Colony of Hong-Kong. But in spite of this emigration of people dying of phthisis, one-ninth of the adult Chinese deaths are due to this cause.1 How much larger a proportion of the living must be affected.

In the absence (in China itself) of statistics one has to fall back upon one's own experience and that of one's fellow-medicals; but here, also, the figures available understate the case, because, as in Hong-Kong, one is not dealing with an unselected sample of the general population, and that for the following reason—native rumour and opinion, an intangible but most potent influence, say that while western medicine offers the best treatment for surgical cases, it is not so valuable for "internal illnesses," so that (unless one is dealing with a well-educated or largely Christian population) medical cases, including phthisis, form but a small proportion of those whom one is called upon to treat. In spite, however, of this "holding back" as it were of cases of internal tuberculosis, most medical men appear to be
struck by the frequency with which they meet with such conditions amongst the Chinese. I think one is justified in saying that the large majority of the deaths amongst the preachers and teachers of missions in China are to be attributed to this "white plague."

My argument may be summarised as follows:—(a) If, in spite of the fact that most cases of pulmonary tuberculosis leave the island of Hong-Kong when they lose hope of recovery, 11 per cent. of the deaths there are due to tubercle, and (b) if, in spite of a "holding back" of medical cases from the practice of medical men on the mainland of China, they are still impressed with the widespreadness of this disease, then how inconceivably great must be the total havoc wrought throughout China by this maleficent bacillus.

Having seen, then, that tuberculosis is prevalent in South-East China, let us now proceed to examine possible reasons for this frequency. They will be dealt with under two main headings, namely:—I. Causes associated primarily with the bacillus. II. Causes that act mainly by rendering the individual more liable to sustain infection.

I. CAUSES ASSOCIATED PRIMARILY WITH THE BACILLUS ITSELF need not detain us long, but the following points may be noted:—

1. The Habit of Spitting is very Prevalent.—There are few habits of the Chinese more striking than the frequency and freedom with which they spit, unrestrained either by a sense of the filthiness of the habit or by a knowledge of the dangers which it may cause to others.

2. The Spitting is Careless and Promiscuous.—In the north of China phthisis is said to be less common because every chair or cart contains a spittoon. This is very far from being the case in the south. Even in railway trains and the waiting-rooms at stations no conveniences are provided, and, still more deplorable, no one seems to notice their absence.

A careful man may endeavour to spit into the drain at the side of the road, but he frequently fails, and careful men are few and far between. In many homes no spittoon is provided, and even a bedridden patient suffering from phthisis may not think it worth while to provide such a receptacle for his expectoration, the ground suffices for his requirements.

3. The Sputum of Tuberculous Patients contains Large Numbers of Living Bacilli.—While generally acknowledging the truth of
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this statement, we do not realise how great is the number expelled daily.

Some years ago the total daily expectoration of a hospital patient was carefully measured, diluted, thoroughly mixed, and a measured quantity of this emulsion of sputum was placed upon a slide, dried and stained. The tubercle bacilli in the whole film were then counted.* The result showed that this patient was expelling about 400,000,000 tubercle bacilli in a day. Granting the accuracy of Kitasato's demonstration that "most of the bacilli in the sputum are already dead," it is obvious that if even a small percentage are alive, the number of living bacilli expelled daily will be enormous.

4. Many of the Living Bacilli thus Expectorated Meet with Conditions Favourable to their Longevity.—Even in the cold season the sun can doubtless destroy in a few hours any bacilli exposed to its rays, and this bactericidal power must be exerted much more rapidly in the height of summer, but we have to bear in mind the habits of the people and their strong aversion to the rays of the summer sun. One thinks of the damp dark houses into which one goes from the blinding light of the sun, houses in which every opening which could let in a single sunbeam has been carefully closed up, one thinks of the narrow streets into which only the perpendicular rays of the meridian sun could penetrate, and one thinks of the way in which these same streets are actually roofed in so that even at noonday no ray can enter.

In South China (and particularly in the north-east part of the Canton Province, which is divided up in a most extraordinary way with water channels) the weather is very often warm and moist, hot without being bright—ideal conditions for the growth of all vegetable life—so one cannot wonder that the tubercle bacilli find ideal places in which to thrive.

As a connecting link between the conditions which are helpful to the bacillus and those which act by rendering man more liable to sustain infection, one must consider two very common methods whereby the bacillus is spread.

(a) By insects from sputum to food. Bacillus coli communis has often been recovered from both the feet and the intestine of the common fly, and living tubercle bacilli have also been isolated from the footmarks of flies that have settled on sputum.

* An oil-immersion lens, a mechanical stage, and an Ehrlich's eye-piece (i.e. a rectangular field) were made use of in this enumeration, which lasted three days.
In South China we have not merely this common fly, but also mosquitoes and other insects in abundance, insects which, in addition to their special power of conveying such diseases as malaria and filariasis, are quite capable of acting as purely mechanical agents in the spread of tuberculosis.*

(b) By social habits, from mouth to mouth. In addition to these natural means of conveying infection, abundant facilities for the spread of the bacillus are also offered by the social habits of the people. A host not only asks his guest to “drink tea” out of a cup which has not been properly washed for several days (and during that time has been used by scores of people), but he also invites him to smoke a pipe which is the common property of the whole household. Similarly, if a feast is given, a kindly host will use the chop-sticks that have been in his own mouth to place a choice morsel in that of his guest.

As tubercle bacilli have been demonstrated in the saliva of over 50 per cent. of cases of open tuberculosis,9 it is obvious that these social customs are attended with considerable risk.

II. Causes that Act Mainly by Rendering the Individual More Liable to Sustain Infection.

The causes that act primarily upon the individual, increasing his susceptibility, may be grouped in various ways. In this article one will consider successively the effects produced upon the health of the individual by (a) the social conditions and customs of the people, (b) by the quality of the air they breathe, and (c) the food they eat, (d) by their clothing, and, finally, (e) by other diseases from which the individual may suffer—the effects produced by opium smoking will be dealt with immediately after the question of diet has been considered.

(A) The General Social Conditions of the People.—This may affect their liability to tuberculosis in at least four distinct ways.

(a) Probably nowhere does one meet with a larger proportion of people living just (only just) above the “starvation line” than one does in China. The majority of the population consists of families that can manage to “get through the day,” but can lay by no savings to meet emergencies. Apart from the effect which this poverty has upon their diet (which will be dealt with

* It would be out of place to discuss here the relative importance of inhalation7 and ingestion8 as causes of tuberculosis, but so long as there is a possibility of the disease being acquired through the alimentary tract the above facts should be borne in mind.
presently), this hand-to-mouth existence is a most potent cause of that care and anxiety which are a man's worst enemies when he is fighting tuberculosis, and which one can readily believe make him more liable to succumb to the attacks of the bacillus.

(b) The fact that "love" is not a determinating factor in arranging the betrothals in China should make it easier to secure a dispassionate consideration of such an important point as the health of the family and of the individual with whom an alliance is to be contracted. To a certain extent this is considered by both the principals engaged in matchmaking, but the betrothals are arranged and earnest-money paid at a very early age, and by the time the parties are old enough to be married phthisis may have developed and even reached quite an advanced stage in one or other of them. An engagement would not have been contemplated with one so obviously diseased, but as troths have already been plighted and good money paid over, the marriage is consummated.

(c) The degree to which considerations of etiquette cause young women to confine themselves within their own homes is another potent factor in the causation of tuberculosis. This injurious influence is most in operation at the ages at which most deaths are caused by this disease. If the older women were confined within doors the results would be less serious; if the young children were thus confined, although their health would doubtless suffer, the mortality from pulmonary phthisis would not be increased; but the confinement of growing women and young mothers cannot but be regarded as a powerful predisposing cause of tuberculosis.

(d) Finally, the effect of the long-continued theatrical performances—though relatively unimportant—should be borne in mind. As these performances rarely close before three or four o'clock in the morning, it is obvious that they must seriously undermine the health of those who habitually frequent them.

(B) The Quality of the Air Breathed.—This factor falls to be considered under two headings, namely, the air breathed by day and that breathed by night, the circumstances under these two conditions differing widely.

The quality of the air a man breathes by day will depend entirely upon his occupation. Is he a bread-winner? If so, does his work keep him in the open air, fishing, rowing, farming, gardening, or carrying loads? Or is he a merchant, occupied in an open shop? Or a clerk, shut up in an office keeping accounts?
Or, worst of all, freed from the necessity of earning money, does he spend his days poring over the classics?

If a man is employed inside a building, then the screens that are used to keep out the sun’s strong beams (as well as the gaze of inquisitive passers-by) will tend to check the free exchange of air.

Unless a man’s business keeps him in the open air he will not find much time nor have much inclination to take outdoor exercise. During the hot weather one cannot feel justified in ordering a man to take exercise during the heat of the day, and the absence of any twilight—as well as the fact that the sunset is the time at which the native here takes his evening meal—makes it a little difficult for him to enjoy a walk in the (relative) cool of the day.

However greatly the quality of the air breathed by different individuals may vary day by day, the conditions at night are more uniform; they almost all sleep in low one-storeyed houses—often one-room houses—and during most of the year within a thick mosquito net. As thieves are numerous, windows and doors are usually closed at night. Over thirty analyses were recently made to ascertain the effect of this defective ventilation upon the amount of carbonic acid gas in the bedroom, with the following results:

|                          | Parts of CO₂ per 100,000. |
|--------------------------|---------------------------|
| In open air              | 40 parts.                 |
| In bedroom, door and window open | 50 parts.                 |
| In bedroom, door shut, window open | 130 parts.               |
| In bedroom, door and window shut | 220 parts.               |

These results do not, however, adequately represent the prevailing conditions, for there was only one occupant in the room, the air of which was analysed, in contrast to the large family and collection of live stock usually found in a native bedroom, for not only is the whole family shut into the house, but the ubiquitous pigs, the cocks and hens, with the addition frequently of a cat and at least one dog, are also housed in the room, to use up the scanty supply of oxygen and to load the air with the organic matter which they expire at every breath.

The disadvantages of this style of living are so obvious that no more need be said about them. If bedridden patients in England—in order to fight against tubercle to the best advantage
—are advised to forsake for the open air the comforts of a well-ventilated bedroom (in which only one inmate consumes the oxygen and contaminates the atmosphere), by how much must the unhygienic surroundings of the people in South China handicap them in resisting this bacillus?

But the influence of the mosquito net is a more insidious factor in vitiating the air one breathes, and the writer recently made a series of tests in order to find out what effect the net had upon the quality of the air within it. Comparative analyses of the air on either side of the mosquito net showed that no obstacle was offered by it to the dissemination throughout the room of the expired carbon dioxide. Further investigations were therefore undertaken to discover whether the air inside the net was vitiated in other ways. It is well known that expired air contains in addition to an increased percentage of carbon dioxide certain effete products of metabolism, and a series of analyses was undertaken to determine the proportionate amount of these bodies in the air inside and outside the net respectively.

It was assumed that by shaking up a definite amount (100 cc.) of distilled water with a sample (5700 cc.) of the air to be examined a certain proportion of the organic matter contained therein would be absorbed by the water. About fifty measurements were made (on successive days) of the amount of oxygen required for the complete oxidation of the organic matter contained in samples of water thus prepared (a) from the air inside the net, (b) from that outside, with the following results:

| State of Ventilation | Temperature of Incubation | Amount of Oxygen Required by Water Sample from Air: |
|----------------------|---------------------------|-----------------------------------------------|
|                      | Outside the Net.          | Inside the Net.                               |
| Poorly ventilated.   | 15 C.                     | 0.00 mgrs.                                    |
| Well ventilated.     | 30 C.                     | 0.13 mgrs.                                    |
| Ventilation fair.    | 30 C.                     | 0.39 mgrs.                                    |
| Poorly ventilated.   | 30 C.                     | 0.41 mgrs.                                    |

The table may be summarised by saying that on the average the air inside the net was twice as impure—as regards organic matter—as that outside the net.

* The analyses were made by Tidy's (Forchammer's) method, the results of which depend to a large extent upon the temperature. Twelve analyses were made under each of the conditions indicated in the table.
When one considers, then, the effect of the closed windows and door and of the mosquito net upon the quality of the air breathed by the bulk of the inhabitants of South China, one sees how totally opposed their environment is to the principles underlying the present open-air methods of treating and of preventing consumption.

(C) The Quality of the Food Consumed.—This question is extremely important, almost fundamental. Of the different predisposing factors considered in this article diet is probably the one that is most amenable to modification by an individual, and the fault which he should remedy is the small amount of proteid in the food consumed.

While fully in agreement with Chittenden and his school that many of the "ills that flesh is heir to" are aggravated by an excess of the products of proteid metabolism in the blood, one cannot but feel that the average adolescent Chinaman contents himself with too little proteid.

One may investigate the question of diet by estimating the content of the food-stuffs in grammes of proteid, of fat, and of carbohydrate, and such a method of study is often necessary, but unless one also makes analyses of the faeces and finds out thus the amount of the food-stuffs which have been ingested but not assimilated, one is apt to be led into error. In many parts of China most of the proteid ingested is derived from vegetables, and a smaller percentage of this proteid is absorbed than of that which is contained in meat. Thus a study of diet sheets without faecal analyses is simply misleading.

As regards the nitrogenous foods the question may, however, be investigated in another way. Of the proteid assimilated a certain amount goes to build up the tissues, taking the place of an equal amount of proteid which has broken down and will subsequently be excreted in the urine; the remainder of the absorbed proteid, not being required for tissue formation, is metabolised into such bodies as urea, uric acid, etc., and likewise makes its appearance in the urine. Thus equivalents of all but a fraction of the proteid assimilated will be found in the urine, and an analysis of this will give us all the information required on the point we are now considering.

Examinations have recently been made of the total daily urine of over one hundred people—students, hospital employees, and patients on full diet—and the results of these analyses agree in showing the very small amount of proteid metabolism that takes place in the bodies of Southern Chinese.
Details of the analyses will be given elsewhere, but attention may be directed here to the excretion of urea and of uric acid in all these cases.

Urea generally contains about 90 per cent.\(^\text{10}\) of the total nitrogen excreted, and according to European and American textbooks from 20 to 40 grms. of this may be excreted daily, 28 grms.\(^\text{11}\) or 33 grms.\(^\text{12, 13}\) being the mean. Eighty per cent. of the urines under consideration contained less than 20 grms. per diem, and the mean was only 12 grms.

In considering these figures it must, however, be borne in mind that the native of South China is shorter and less heavily built than the average European, so that one should compare the amount of urea excreted per kilogramme of body weight rather than the absolute amounts excreted per diem. In contrast to the European standard\(^\text{14}\) of '4 to '7 grms. per kilo., four-fifths of the cases under consideration gave less than '4 grms. per kilo., the usual figure being between '2 and '29 grms. per kilo.

A further point is that, owing to the increased amount of urine generally passed by natives in this part of China, the urea is excreted in an even more dilute solution than one would expect from the small amount of this body excreted daily. Thus in place of the urine containing from 2 per cent. to 3 per cent. of urea (\(i.e.\) the percentage generally met with amongst Europeans),\(^\text{14}\) the figures most generally found in the series of cases examined were from '8 per cent. to 1 per cent., and in over half the cases the urine contained less than 1 per cent. of urea, that is, less than one-half to one-third of the concentration met with in European urines.

May not this be taken to indicate that the blood of a Chinaman holds only from one-half to one-third of the amount of urea contained in the blood of a European? When one considers the extraordinary beneficial effects that have followed the use of urea\(^\text{15}\) in some tuberculous cases, the small amount of urea in the circulating blood cannot fail to impress one as an important factor in weakening the resistance to tuberculosis.

Similarly, uric acid (which has given excellent therapeutic results in cases of phthisis, and may be expected to have at least as powerful an influence as a preventive) is found in the urine of the natives here (and doubtless therefore in their blood) in much less amount than in Europeans. This is shown in the following table:
Excretion of Uric Acid.  

| Excretion of Uric Acid. | Standard given in Home Text-Books (14) (16). | Results of Analyses of 100 Chinese Urines. |
|------------------------|---------------------------------------------|------------------------------------------|
| Per cent. in urine.    | 0.024-0.060 per cent.                       | 0.016-0.030 per cent.                    |
| Total daily amount.    | 4.7 grms.                                   | 2.4 grms.                                |

By administering either urea or uric acid in appropriate doses one can increase the amount of these substances in the circulating blood, and thus increase a patient's power of antagonising the tubercle bacillus, but the simplest and most natural way of thus increasing his capacity for resistance is by increasing the amount of easily assimilable proteid in his food—a method widely used in the treatment of tuberculosis. 17, 18, 19

The value of a diet rich in nitrogenous matter in preventing tuberculosis is shown by the rare occurrence of phthisis in gouty families; it is practically never met with in one who himself suffers from gout. This disease I have not met with, nor heard of, in the course of six years' practice in South China, and its absence indicates the lack of a prophylactic much to be desired.

Having thus demonstrated the defects in the diet of the Southern Chinese, let us proceed to consider the effect of opium.

The habit of smoking opium may weaken a man's power of resistance to tuberculosis in any one—or in all three—of the following ways:

(a) A poor man can only purchase such an expensive drug as opium by foregoing the purchase of a certain amount of nourishing food. He is, as a rule, unable to confine himself to an amount of opium so small that the cost will not interfere with his ability to buy the amount of rice, etc., to which he is accustomed. Hence, on the one hand, the emaciated appearance of so many opium smokers (see also next paragraph), and, on the other hand, the idea held by many Chinese that while it is not wise for a poor man to smoke opium, there is no harm in a rich man's doing so.

(b) The opium habit has a deleterious effect upon the gastric juice, diminishing both the amount of hydrochloric acid and the pepsin; it thereby decreases the power of digesting proteid. Since, even in one who does not smoke opium, the amount of proteid assimilated is small (as has been shown by an examination of the urine), any further diminution in this cannot but be regarded as serious.

(c) Opium weakens the resistance to tuberculosis by diminish-
ing the power of the white blood cells to destroy living bacilli. This diminished phagocytosis has been experimentally demonstrated in cases of acute abdominal infections in which morphia has been administered; there is no reason to doubt that the same deleterious influence is exerted upon the blood by daily indulgence in the opium habit.

There is still another way in which indulgence in opium smoking renders a man more liable to become infected by the tubercle bacillus. The smoker generally spends several hours daily in an “opium den,” which is not merely dirty and ill ventilated, but usually abounds with tubercle bacilli. The explanation of this latter fact is that the Chinese are quite familiar with the efficiency of opium in relieving many of the symptoms of pulmonary tuberculosis. Many a man who wishes to be cured of the craving for opium tells how the habit was first indulged in to check haemoptysis, to secure relief from an intractable cough, to diminish “night sweats,” or for some other well-known symptom of tuberculous disease. It is the presence of advanced cases of tuberculosis in the opium den that makes these such important centres for the spread of tuberculosis.

(D) The Clothing Worn.—Another predisposing cause of pulmonary tuberculosis is to be found in the unsatisfactory nature of the wearing apparel of the natives.

Till recent years the clothes of the ordinary native have consisted simply of cotton, a material that is to be regarded as most unsatisfactory on account of its inability to absorb perspiration and to protect from cold winds. In the coldest weather the same material is used, with this difference, that the coat and waistcoat are made in two layers, the intervening space being padded with cotton-wool.†

* It may be gathered from the above that, in the opinion of the writer, it would be a profound mistake to assume that every emaciated tuberculous opium habitué owes his diseased condition to indulgence in this drug. It is quite as likely that, but for the relief afforded by opium and its powers as a “proteid-sparer,” the patient would have succumbed to tuberculosis many years previously. During the “anti-opium crusade” that has been such a striking feature of recent years in China there have been few more pathetic incidents than the death of men still in their prime, in whom the sudden and ill-advised cutting off of the daily supply of opium has led to acute exacerbations of pulmonary tuberculosis.

† For the benefit of any readers not familiar with the habits of Southern Chinese it may be stated that the average native does not wear a shirt, but a series of coats, occasionally surmounted by a waistcoat. The number of coats is increased or diminished according to the temperature.
Recently there has been a considerable increase in the import of "health shirts"—garments corresponding to what would be under-vests in Europe. These are being much worn by the student and merchant classes, and, it is to be hoped, will make for relative freedom from chills, and therefore from bronchitis and other conditions that predispose to tuberculous disease of the lungs.

(E) Other Diseases.—In the first place, we may put aside the idea of there being any specific antagonism between malaria and tuberculosis.*

One feels justified in assuming, on general principles, that the weakness due to chronic malaria and to other causes of tropical splenomegaly and anæmia must render the victim of these affections more likely to yield foothold to the tubercle bacillus. Ankylostomiasis is another condition which, by impoverishing the blood, weakens the power of resistance to the tubercle bacillus, a fact which is well brought out in Heisser's tables of mortality for Manilla, where it is shown that the death-rate from phthisis is twice as great amongst cases of ankylostomiasis as amongst the rest of the population. The seriousness of this condition as regards the occurrence of tuberculosis in South China will be obvious when one reports that about 60 per cent. of one's hospital patients harbour this parasite.

Apart from these general diseases there is one pulmonary condition which, though rarely met with in China proper, is very common in the northern part of the neighbouring island of Formosa, namely, infection with distoma pulmonale. I have only met with one case of this in China, and this patient showed simultaneous infection with the tubercle bacillus. This is only what one would expect, for where could an inhaled bacillus find a better nidus in which to settle and multiply than in the broken-down and bleeding patch of lung prepared by this distoma?

In conclusion, let us take a brief glance at the reasons which have been assigned for the prevalence of tuberculosis in South-East China. On the one hand, on account of the habits of the people and the climatic conditions under which they live, we have seen that living tubercle bacilli may be met with in large numbers

* This idea was probably due to its being noticed that sometimes Europeans who had been tuberculous in their own country improved when they went to live in India or other tropical region where malaria was common. The improved health is to be attributed to the greater purity of the air breathed in lofty bedrooms with widely opened windows, to the more "open-air" conditions of life in the tropics.
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—may by the social customs of the people be transferred directly from mouth to mouth—and, on the other hand, we have noted that not only do the unhygienic surroundings amidst which the people live, and the mosquito net within which they sleep, seriously impair the quality of the air they breathe, but also that their dietetic habits and the illnesses from which so many of them suffer markedly weaken their power of resistance to the inroads of this omnipresent bacillus.

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