

A practical treatise on the sputum, with special reference to the diagnosis, prognosis and therapeusis of diseases of the throat and lungs / by G. Hunter Mackenzie.

Contributors

Mackenzie, George Hunter.
Clark, Andrew, 1826-1893
Clark, Helen Annette, -1922
Royal College of Physicians of London

Publication/Creation

Edinburgh : W. & A.K. Johnston, 1886.

Persistent URL

<https://wellcomecollection.org/works/unentxs3>

Provider

Royal College of Physicians

License and attribution

This material has been provided by This material has been provided by Royal College of Physicians, London. The original may be consulted at Royal College of Physicians, London. where the originals may be consulted. This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

ESSAYS ON

RESPIRATORY DISEASES

HUNTER MACKENZIE

I

A PRACTICAL TREATISE

ON THE

S P U T U M

616.22 008.8 S.L.
The Royal College of Physicians
of London.

*From the Library of
Sir Andrew Clark, Bart.*

Presented by Lady Clark.

147 D 8



11

A
PRACTICAL TREATISE
ON THE
S P U T U M

WITH SPECIAL REFERENCE

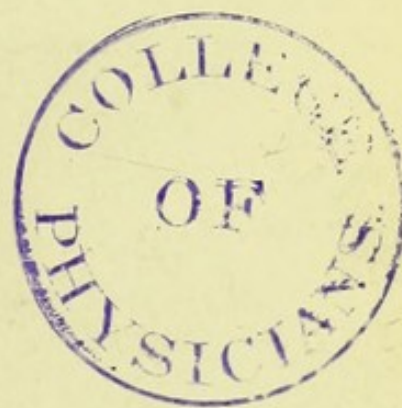
TO THE

Diagnosis, Prognosis, and Therapeusis of Diseases
of the Throat and Lungs

By

G. HUNTER MACKENZIE, M.D. (EDIN.)

LECTURER ON PRACTICAL LARYNGOLOGY AND RHINOLOGY IN THE
EXTRA-ACADEMICAL SCHOOL OF MEDICINE, SURGEON FOR THROAT
DISEASES TO THE EYE, EAR, AND THROAT HOSPITAL, AND TO
THE WESTERN DISPENSARY, EDINBURGH



W. & A. K. JOHNSTON
EDINBURGH AND LONDON

ROYAL COLLEGE OF PHYSICIANS LIBRARY	
CLASS	616.22-008.8
AOCH.	24259
SOURCE	
DATE	

PRINTED BY W. AND A. K. JOHNSTON, EDINBURGH AND LONDON.

P R E F A C E.

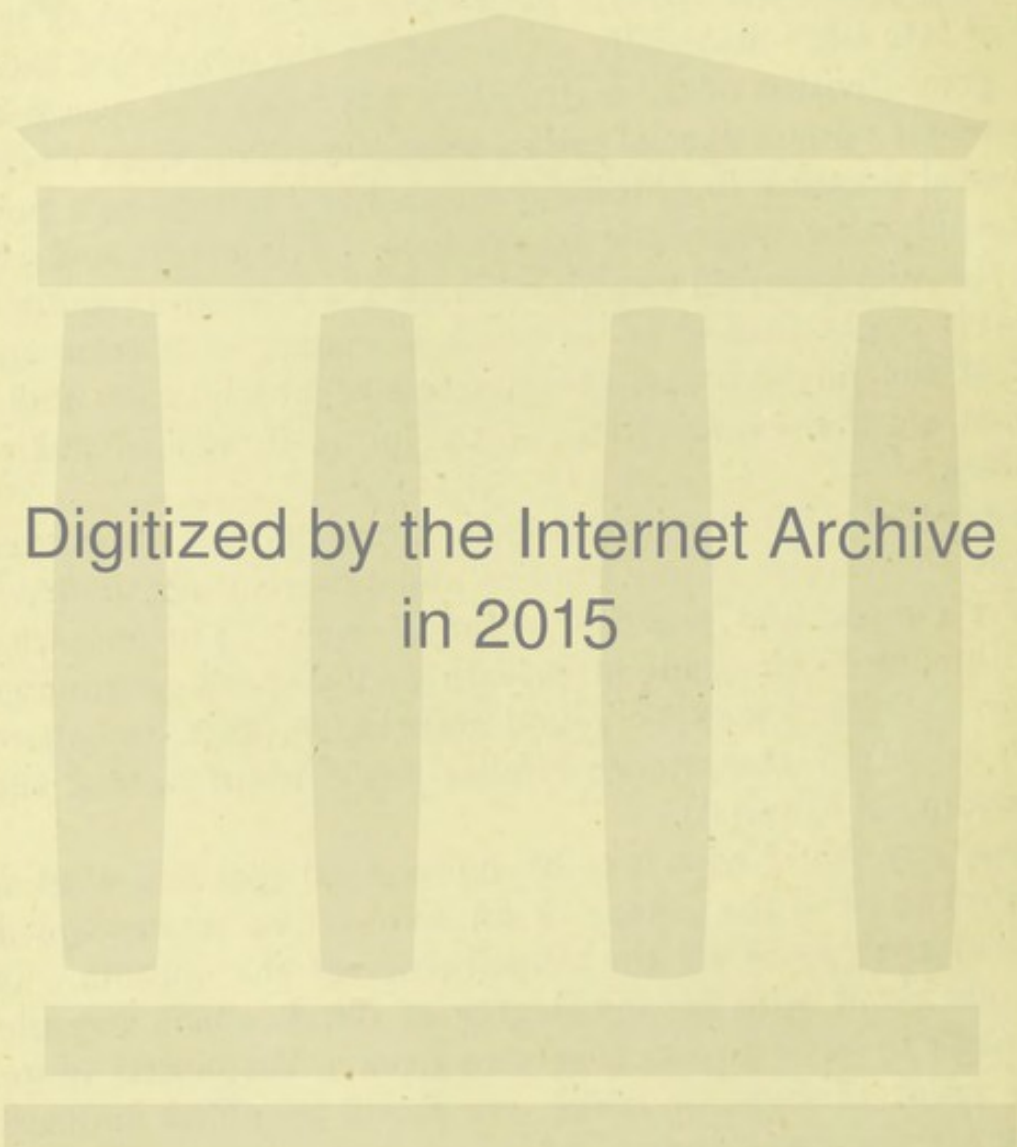


ANY value which has hitherto been attached to the systematic examination of the sputum in diseases of the respiratory system has of late been materially enhanced by the important fact that one great division of these disorders has been discovered to be dependent upon a special micro-organism which, from its almost universal presence in phthisical sputa, has attained to a position of considerable diagnostic importance. The study, and especially the microscopical examination, of the sputum in pulmonary diseases ought thus to be as much a matter of routine on the part of the physician, as the practice of auscultation and percussion, or the examination of the urine in vesical and renal diseases.

Impressed with the importance of this subject, I venture to submit the results of my studies and observations, undertaken from a clinical and practical point of view. The majority of these having been made in private and dispensary practice, it follows that they may be found wanting in that completeness which ought to characterise similar work when carried out in well-equipped hospitals.

I may say that I wish it to be understood that this work does not affect to be of the nature of an exhaustive microscopical or chemical analysis of all the constituents of the sputum. Only those are dealt with in any degree of detail which experience has shown to be of practical service from a diagnostic or prognostic point of view, or which are found to afford indications for therapeutic applications.

I NORTHUMBERLAND STREET,
EDINBURGH, *February 1886.*



Digitized by the Internet Archive
in 2015

<https://archive.org/details/b24906906>

CONTENTS.

CHAPTER I.

	PAGE
INTRODUCTION	I

CHAPTER II.

THE SPUTUM IN CATARRH, BRONCHITIS, BRONCHIECTASIS, PUTRID BRONCHITIS, CROUPOUS BRONCHITIS, ASTHMA, GANGRENE OF THE LUNG, ABSCESS OF THE LUNG, CATARRHAL PNEUMONIA, PULMONARY HYPERÆMIA, EMPYEMA	4
---	---

CHAPTER III.

THE SPUTUM IN CROUPOUS PNEUMONIA AND IN ZYMOTIC DISEASES	12
---	----

CHAPTER IV.

THE SPUTUM IN PHTHISIS OF THE LUNGS (ELASTIC TISSUE)	17
--	----

CHAPTER V.

THE SPUTUM IN PHTHISIS OF THE LUNGS (<i>continued</i>) (TUBERCLE BACILLI)	24
--	----

CHAPTER VI.

THE SPUTUM IN PHTHISIS CALCULOSA, TRAUMATIC PHTHISIS, PNEUMO-MYCOSIS, AND ANTHRACOSIS	44
--	----

CHAPTER VII.

THE SPUTUM IN CERTAIN AFFECTIONS OF THE NOSE, MOUTH, AND PHARYNX, AND IN DISEASES OF THE LARYNX—TUBER- CULOSIS, CANCER, SYPHILIS, CHRONIC INFLAMMATION, LUPUS	47
--	----

CHAPTER VIII.

HÆMORRHAGE IN THE SPUTUM	PAGE 54
------------------------------------	------------

CHAPTER IX.

THERAPEUTIC INDICATIONS OF THE SPUTUM IN LUNG DISEASE —(PROPHYLACTIC AND REMEDIAL—THE INFLUENCE OF CLIMATE)	61
--	----

CHAPTER X.

THERAPEUTIC INDICATIONS OF THE SPUTUM IN LUNG DISEASE (<i>continued</i>)—(THE INFLUENCE OF LOCAL AND GENERAL REMEDIES)	75
---	----

CHAPTER XI.

THERAPEUTIC INDICATIONS OF THE SPUTUM IN LARYNGEAL AND ALLIED DISEASES	90
---	----

CHAPTER XII.

DISINFECTION OF THE SPUTUM	93
--------------------------------------	----

CHAPTER XIII.

METHODS OF EXAMINING THE SPUTUM	95
INDEX	101

LIST OF ILLUSTRATIVE CASES.

No.	PAGE
1. Pleurisy with pulmonary inflammation : presence of schizomycetes and absence of tubercle bacilli from the sputum	10
2. Hydrothorax with pulmonary congestion : presence of pneumococci and schizomycetes in the sputum	15
3. Chronic bronchitis : elastic tissue in the sputum	21
4. Simple catarrh : elastic tissue in the sputum	22
5. Chronic laryngitis : elastic tissue in the sputum	22
6. Chronic pneumonia in a syphilitic subject : elastic tissue in the sputum	22
7. Pseudo-phthisis : no bacilli : recovery	26
8. Pseudo-phthisis : no bacilli : recovery	26
9. Pseudo-phthisis : no bacilli : recovery	26
10. Chronic pneumonia (syphilitic) : no tubercle bacilli in sputum	27
11. Pulmonary hæmorrhage, probably cardiac : no bacilli : recovery	27
12. Pleurisy : empyema rupturing into bronchi : no tubercle bacilli in sputum	27
13. Bronchiolitis mimicking phthisis : no tubercle bacilli in sputum	28
14. Acute pulmonary phthisis without cough or expectoration	30
15. Incipient bacillary phthisis without fever : recovery	31
16. Incipient bacillary phthisis without fever : slight hæmorrhage : recovery	31
17. Bacillary phthisis : no fever during early stages	31
18. Bacillary phthisis : no fever and equivocal physical signs during early stages	31
19. Bacillary phthisis without fever or recognisable physical signs	32
Table showing the Evening Temperature in a case, æt. twelve, of slow bacillary phthisis	33
20. Acute bacillary phthisis : enormous numbers of tubercle bacilli in the sputum : rapid death	38
21. Chronic pulmonary phthisis with cavities : no tubercle bacilli in sputum	39
22. Probable fibroid phthisis of lung : tubercle bacilli in sputum	40

No.	PAGE
23. Laryngeal carcinoma, with granulation-tissue growths in the sputum	51
24. Bacillary phthisis, with severe initial hæmorrhage : very slight recurrence	55
25. Bacillary phthisis, with severe initial hæmorrhage : very slight recurrence	56
26. Bacillary phthisis, with free initial hæmorrhage : no recurrence .	56
27. Results on bacilli of residence at Tunbridge Wells, in the Riviera, and in Switzerland	69
28. Results on bacilli of residence at Bournemouth, in Scotland, the Riviera, Algeria, and in Switzerland	70
29. Results of residence on land, and on the sea	71
30. Results of residence in Scotland, and of a voyage to Australia .	72
31. Results of residence in the Lowlands of Scotland, and in an elevated Highland district	72
32. Results of residence in Scotland, at Bournemouth, and at Ventnor, Isle of Wight	73
33. Early phthisis : effect of antiseptic inhalations upon the bacilli of tubercle	77
34. Early phthisis : persistence of tubercle bacilli after treatment by antiseptic inhalations	77
35. Phthisis pulmonalis : great increase of tubercle bacilli during treatment by antiseptic inhalations	78
36. Early phthisis : effect of antiseptic inhalations upon the bacilli of tubercle	79
37. Phthisis pulmonalis : persistence of tubercle bacilli during treatment by antiseptic inhalations	79
38. Laryngeal and pulmonary phthisis : effect of the bichloride of mercury spray upon the bacilli of tubercle	80
39. Case of laryngeal and pulmonary tuberculosis, originating in simple chronic laryngitis : effects of iodoform treatment .	82

LIST OF ILLUSTRATIONS.

FIG.	PAGE
1. Extraneous fibres from the sputum	2
2. Constituents of the sputum	5
3. Constituents of the sputum	5
4. Curschmann's spiral, bronchiolar cast, Charcot (Leyden) crystals, and epithelial cells from the sputum	6
5. General débris of the sputum,—fungous filaments, epithelial and pus cells, spores, and organisms	7
6. Schizomycetes from the sputum	10
7. Pneumo-cocci from the sputum	14
8. Chart showing the morning and evening temperature in a case of hydrothorax, with pulmonary hyperæmia—pneumo-cocci in the sputum	15
9. Alveolar epithelial cells in abundance from a case of very early phthisis (<i>Micro-photo-lithograph</i>)	20
10. Crystals from the sputum in bronchitis, bronchiectasis, and phthisis	20
11. Shreds of pulmonary and laryngeal elastic tissue from the sputum	22
12. Pulmonary elastic tissue from the sputum in a case of chronic bacillary phthisis (<i>Micro-photo-lithograph</i>)	23
13. Diagrammatic representation of the forms assumed by the bacilli of tubercle	24
14. Bacilli of tubercle and pus cells of the sputum	24
15. Chart showing the morning and evening temperature in a case of sub-acute bacillary phthisis	32
16. Chart showing the relation of the body-weight to the number of bacilli in the sputum in a case of chronic phthisis	35
17. Calculi from the sputum	44
18. Bacilli of tubercle from the sputum in a case of laryngeal phthisis	49
19. Arytenoid cartilage from the sputum in a case of laryngeal phthisis	50
20. Laryngeal elastic tissue from a case of chronic (strumous) laryn- gitis without pulmonary disease (<i>Micro-photo-lithograph</i>)	50
21. Cell nest from the sputum in a case of epithelioma of larynx (<i>Micro-photo-lithograph</i>)	50

FIG.		PAGE
22.	Cell-nest from the sputum in a case of epithelioma of larynx (<i>Micro-photo-lithograph</i>)	50
23.	Granulation-tissue from the sputum in a case of carcinomatous disease of the larynx (early stage) (<i>Micro-photo-lithograph</i>)	51
24.	From the sputum in a case of carcinomatous disease of the larynx (early stage) (<i>Micro-photo-lithograph</i>)	51
25.	Granulation growths from the sputum in a case of carcinoma of the larynx	51
26.	From the sputum in a case of carcinomatous disease of the larynx (advanced stage) (<i>Micro-photo-lithograph</i>)	51
27.	From the sputum in a case of benign (papillomatous) tumour of the larynx (<i>Micro-photo-lithograph</i>)	52
28.	Chart showing the effects of different climates upon the numbers of tubercle bacilli in a case of chronic phthisis	70
29.	Chart showing the influence of residence on land and on the sea, on the numbers of tubercle bacilli in a case of chronic phthisis	71
30.	Fungus and spores (leptothrix) from the sputum in a case of pulmonary phthisis after recovery	75
31.	Chart showing the bacillary course of a case of phthisis under treatment by antiseptic inhalations	78
32.	Fungous filaments from the sputum	97
33.	Fungous filaments from the sputum	97

CHAPTER I.

INTRODUCTION.

THE diseases of the respiratory system which are not characterised by excessive secretion are few in number. The presence of this excess of secretion in the respiratory passages is intolerable to the sensitive mucous lining, which consequently, by reflex action, endeavours by dint of coughing to rid itself of the cause of irritation. The degree of irritability varies not only in different individuals, but also in the same individual according to the particular seat or locality of the irritation. Thus, in the larynx and trachea there are known to be several small areas of hyper-sensitiveness, such as the inter-arytenoid region and the bifurcation of the trachea, which are quite intolerant of the slightest accumulation of secretion, and are hence known as "cough-spots," whilst in their immediate neighbourhood the secretion may accumulate for some time without exciting any attempts at dislodgment. The frequency and intensity of attacks of coughing may be stated to be directly proportional to the degree of irritation of the respiratory mucous membrane. Examples of this are seen in cases of phthisical cavities. These are frequently very tolerant of their contents, and it is only after such an accumulation has taken place as leads to irritation of the adjoining mucous membrane, that coughing and evacuation occur. Irritation of the pleura may also cause cough : hence simple pleuritis may have cough as one of its symptoms.

The effect of the act of coughing is usually to cause the ejection of the irritating substance, with the probable addition of some other fluids and secretions, such as saliva from the mouth. In young children this ejection seldom takes place, the secretion being usually swallowed ; this, consequently, renders it

difficult to obtain specimens of children's expectoration for examination.

The examination of the sputum may be macroscopic or microscopic in character. By the former method attention is directed to its amount, colour, consistence, and deposits; by the latter to its more intimate composition. Thus microscopical examination may reveal the presence of cells, tissues, crystals, pathogenic and non-pathogenic organisms, together with certain extraneous particles such as dust, fungi, fibres of hair, cotton wool, and other impurities derived from the atmosphere and varying according to the general surroundings and occupation of the individual. These extraneous matters may be found in sputa independently of any particular disease, and their presence deserves recognition only by reason of the possibility of mistaking some of them for fragments of lung tissue. In the therapeusis of the respiratory passages or organs, solids, insoluble or soluble only to some extent in water, may have been employed: if so, these may form insoluble compounds with the albumen and mucus of the sputum, in which they may be frequently detected. Thus iodine, when administered internally, whether as free iodine or as a salt, may be readily detected in the mucus of the expectoration.

The sputum, therefore, possesses a double set of characteristic constituents—those which belong more or less to all varieties apart from any particular disease and are thus of slight diagnostic import, and those which, being met with in one disease only, may be considered as pathognomonic or symptomatic in character. Each of these classes is capable of illustration, the one by epithelial cells, the other by tubercle bacilli; for whilst the former are practically valueless in the accurate diagnosis of disease, the latter are of extreme diagnostic value. Similarly, the macroscopic character may be more or less symptomatic or the reverse, as illustrated by the croupous pneumonic and the bronchitic sputa; in this case, however, the difference between the two classes is neither so definite nor so absolute as in the case of the microscopical properties.

The composition of the sputum is thus of a somewhat varied nature according to the particular area of the respiratory passages from which it is mainly derived, the disease

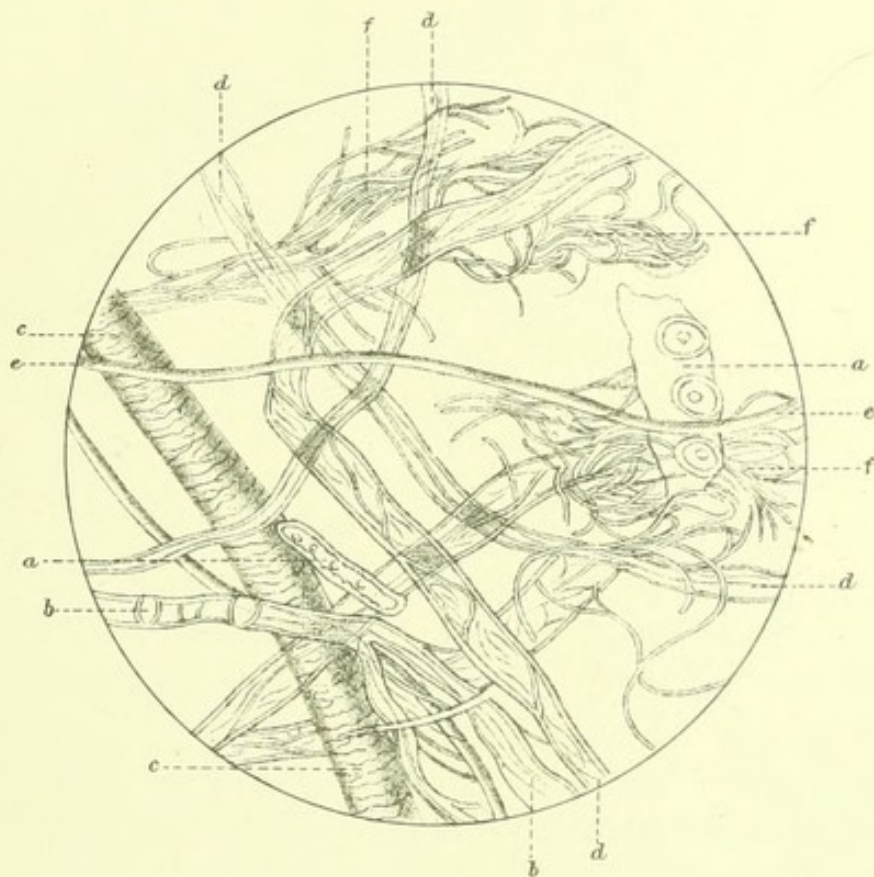


Fig. 1.—EXTRANEOUS FIBRES FROM THE SPUTUM ($\times 300$).
a. Pine wood, probably from sweepings of floor ; *b.* Fibre of flax splitting into leash at end ;
c. Fragment of hair ; *d.* Cotton fibre ; *e.* Silk fibre ; *f.* Elastic tissue added for purposes
of comparison.



with which it is associated, and the extent to which adventitious particles have become mixed with it. If we except such diseases as tubercle and pneumonia, and neoplasms, it can hardly be said that the various pulmonary affections possess such sputa - characteristics as enable the observer to make differential diagnoses with absolute certainty. As the pathological and clinical features of several of these diseases approximate closely to, or shade gradually into each other, so the characters of the sputa are more general than particular. More emphatically is this the case with the members of the simple inflammatory group, such as catarrh, bronchitis, and asthma.

It ought to be borne in mind that the examination of a specimen of sputum may be valuable from a negative as well as from a positive point of view, from what it does not, as well as from what it does, contain. Thus, though in a dubious specimen of sputum there may be found only a few mucus corpuscles with an admixture of pus and epithelial cells, if the observer is able to satisfy himself that tubercle bacilli and elastic lung tissue are absent, an important aid in diagnosis will have been arrived at. A negative observation of this sort is extremely difficult to make, and requires great care and repeated trials before the results arrived at can be accepted as accurate. As the methods and rules for examining sputa have been fully enunciated in the concluding chapter, it is considered unnecessary to make further reference to them at this stage.

CHAPTER II.

THE SPUTUM IN CATARRH, BRONCHITIS, BRONCHIECTASIS, PUTRID BRONCHITIS, CROUPOUS BRONCHITIS, ASTHMA, GANGRENE OF THE LUNG, ABSCESS OF THE LUNG, CATARRHAL PNEUMONIA, PULMONARY HYPERÆMIA, EMPYEMA.

THE sputa of this group of respiratory diseases are distinguished by the absence of any specific organism or organisms, and herein lies the great feature which differentiates them from the specific class.

Their macroscopic appearances vary from a watery mucous to a thick purulent consistence, with or without the presence of sanguineous streaks. The catarrhal sputum is frequently of a dark grey colour, from the admixture of ordinary dust. In certain forms of bronchitis, casts consisting of inspissated mucus may be readily recognised by the naked eye. The sputum is usually odourless, but in certain forms of bronchitis, with bronchial dilatation and impairment of the contractile power of the bronchial muscles, it may collect and decompose within the tubes before being expectorated. It can scarcely, however, be said that there is anything in the macroscopic appearances of the sputa of this group, which can aid in distinguishing the various members of it from each other, or even from those of the succeeding class.

In simple catarrh (catarrhal inflammation) of the respiratory passages sputum may be absent, especially in the earlier stages (dry catarrh): when present it is generally composed of a viscid fluid rich in mucine, and containing mucus-corpuscles and epithelial cells. Cells from the minute bronchi and pulmonary alveoli are generally absent in this form of catarrh. Air bubbles are usually present in quantities proportionate to the severity of the cough, for, as a rule, the more frothy the sputum, the more tenacious and difficult of expectoration it is.

CHAPTER II.

THE SPUTUM IN CATARRH, BRONCHITIS, BRONCHIECTASIS, PUTRID BRONCHITIS, CROUPOUS BRONCHITIS, ASTHMA, GANGRENE OF THE LUNG, ABSCESS OF THE LUNG, CATARRHAL PNEUMONIA, PULMONARY HYPERÆMIA, EMPYEMA.

THE sputa of this group of respiratory diseases are distinguished by the absence of any specific organism or organisms, and herein lies the great feature which differentiates them from the specific class.

Their macroscopic appearances vary from a watery mucous to a thick purulent consistence, with or without the presence of sanguineous streaks. The catarrhal sputum is frequently of a dark grey colour, from the admixture of ordinary dust. In certain forms of bronchitis, casts consisting of inspissated mucus may be readily recognised by the naked eye. The sputum is usually odourless, but in certain forms of bronchitis, with bronchial dilatation and impairment of the contractile power of the bronchial muscles, it may collect and decompose within the tubes before being expectorated. It can scarcely, however, be said that there is anything in the macroscopic appearances of the sputa of this group, which can aid in distinguishing the various members of it from each other, or even from those of the succeeding class.

In simple catarrh (catarrhal inflammation) of the respiratory passages sputum may be absent, especially in the earlier stages (dry catarrh): when present it is generally composed of a viscid fluid rich in mucine, and containing mucus-corpuscles and epithelial cells. Cells from the minute bronchi and pulmonary alveoli are generally absent in this form of catarrh. Air bubbles are usually present in quantities proportionate to the severity of the cough, for, as a rule, the more frothy the sputum, the more tenacious and difficult of expectoration it is.

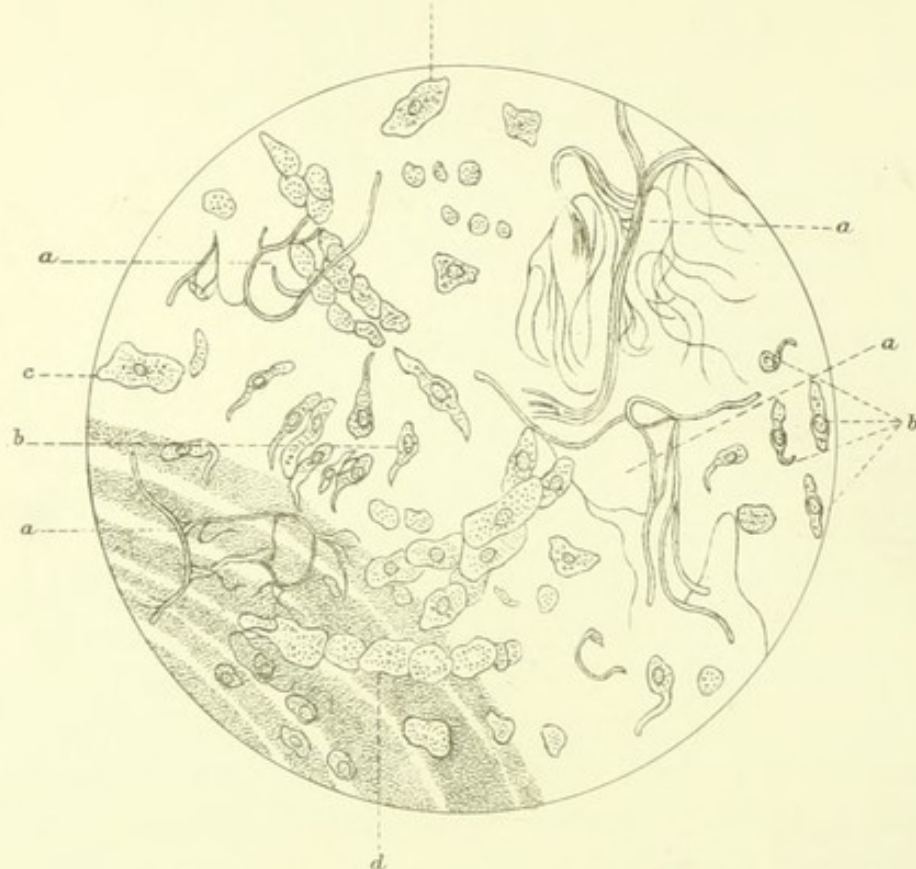


Fig. 2.—CONSTITUENTS OF THE SPUTUM ($\times 300$).

a. Elastic tissue ; *b.* Columnar cells from very minute bronchi ; *c.* Epithelial scales from mouth ;
d. Swollen alveolar epithelium, pigmented and fatty.

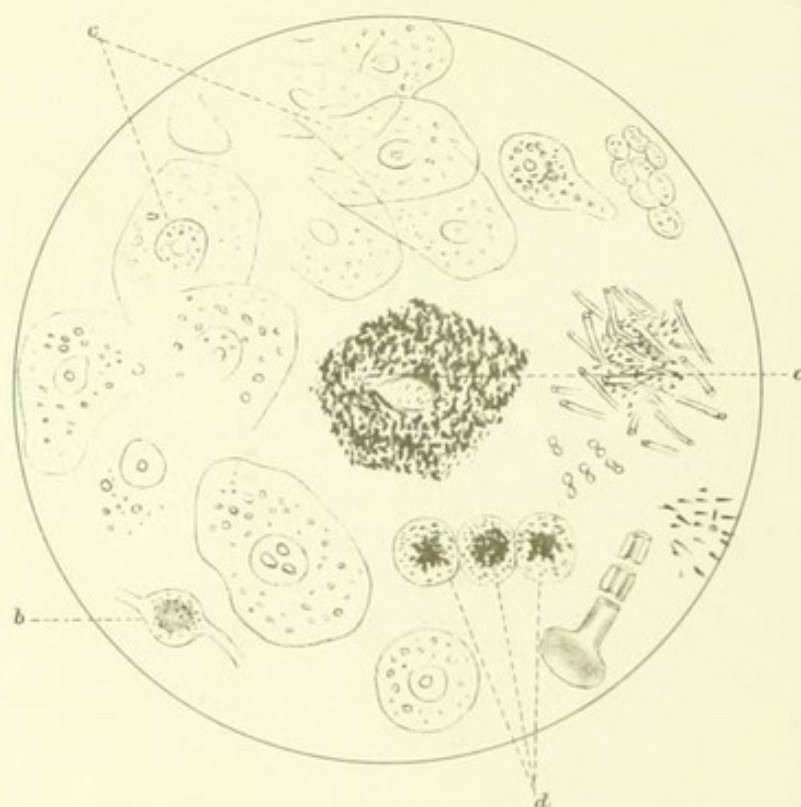


Fig. 3.—Same as preceding, more highly magnified.

Towards the termination of the complaint "sputa cocta" appear, consisting of a thicker, more purulent, and globular form of expectoration. This variety of sputum, in the early stages, closely resembles that of commencing tubercular disease, from which it is distinguished by the possession of certain negative characters to be afterwards described. According to the nature of the expectoration LÆNNEC¹ described catarrh as mucous, pituitary, dry, fetid, etc. and this classification is still adhered to by some authors. The attempt to distinguish between a mucous, a purulent, and an epithelial catarrh has not resulted in any diagnostic gain, for all these varieties may alternate in the same case without any material change of catarrhal conditions.

The bronchitic and asthmatic sputa possess few features of diagnostic importance. The appearances presented by the former may be mainly mucous, muco-purulent, or purulent, according to the intensity, extent, and duration of the disease. In the "dry catarrh" of LÆNNEC is a variety of chronic bronchitis distinguished by severe attacks of coughing, and very scanty expectoration, of tenacious consistence, and greyish colour. It appears to be owing to a catarrh of the smaller bronchi. The seat of the inflammation and the consistence of the secretion account for the great difficulty of expectoration, and the consequent exhaustion which it entails. This "dry catarrh" may present various degrees of intensity, even in the same individual. Sanguineous streaks are occasionally present without possessing any evil import: when persistent, however, or of a recurrent nature, they are said to precede the development of phthisis.

The pure asthmatic sputum is generally seen immediately after the attack: it is usually viscid, copious, mucous, and frothy, with an admixture of fine plugs and threads. During the intervals of the attacks of asthma, sputum may be entirely absent.

Microscopical examinations of these sputa show the presence of epithelial cells, fibres, tube-casts, crystals, and the general débris common to most sputa. Ciliated epithelial cells are rarely present. Elastic tissue may be present in chronic bronchitis (Case 3), without the individual evincing any tendency to phthisis. Fibrinous casts of the minute bronchial tubes are occasionally found, with a straight, branching, dichoto-

¹ Traité de l'Auscultation, Paris, 1837.

mous arrangement. CURSCHMANN'S spirals may sometimes be detected (Fig. 4). According to their discoverer,¹ they indicate the existence of inflammation of the minute bronchioles (bronchiolitis), and are thought by him to afford some therapeutic indications, to which reference will again be made. They appear to be formed from the columnar cells of the minute bronchi. In croupous bronchitis the casts may be of large size, and are readily recognised by the naked eye. The larger varieties are usually hollow, and contain mucus mixed with air. The smaller casts may be detected by teasing out and examining the sputum in water. They divide and subdivide after the manner of the bronchi and bronchioles, are usually tolerably firm in consistence, and are composed of fibrine with pus, epithelial, and sometimes blood cells. When large and numerous these casts have been known to produce death by asphyxia. Their presence is of extreme value in the diagnosis of croupous bronchitis (Fig. 4). The crystals met with are known as CHARCOT'S crystals, after the name of their discoverer. They present the appearance of colourless, pointed, octohedral bodies of various sizes, insoluble in alcohol, ether, or chloroform, but soluble in acids and alkalies (Fig. 4). From their frequent presence in the asthmatic sputum LEYDEN thought that they had a causal relationship to the asthmatic attack—that by irritating the terminal twigs of the vagus in the pulmonary mucous membrane they gave rise, by reflex action, to the asthmatic seizure. This hypothesis appears now to be disproved, for they have been found in the sputa of individuals who never suffer from asthma, but from such diseases as chronic bronchial catarrh and croupous bronchitis. They are supposed to originate in the decomposition of the mucilaginous substances of the bronchial secretion. OERTEL states that he has witnessed the formation of these crystals under the microscope from the fungi (micrococci) which cause the decomposition of this secretion. At all events their presence is of slight etiological or diagnostic importance, and the utmost that can be said is that they, along with CURSCHMANN'S spirals, are usually present in the inflammatory affections of the smaller bronchioles, with or without the co-existence of asthma.

¹ Deutsch. med. Wochenschrift, 1884, No. 3.



Fig. 4.—CURSCHMANN'S SPIRAL, BRONCHIOLAR CAST, CHARCOT (LEYDEN) CRYSTALS, AND EPITHELIAL CELLS FROM THE SPUTUM ($\times 350$).





Fig. 5.—GENERAL *débris* OF THE SPUTUM.
Fungous filaments, spiral epithelial, and pus cells, crystals, spores, and organisms ($\times 350$).

W. & A. F. Johnson, Edinburgh & London.

In bronchiectasis and putrid bronchitis, the sputum is stringy, muco-purulent, fetid, and of a dirty greenish colour. In fact, the fetid odour of the sputum is the distinguishing characteristic of these diseases; otherwise, it does not differ from the expectoration of chronic bronchial catarrh. It is usually expectorated with great difficulty, partly on account of the weakness of the individual, but chiefly by reason of the basic situation of the cavities, and the alterations of the bronchial tubes and muscles inducing consequent impairment of their expectorating power. This retention of the pulmonary secretion from inability to expectorate may lead to constitutional impairment. It is expectorated in large quantities and at long intervals, and abounds with schizomycetes of several kinds, to which the putrefaction is evidently due. Fan-shaped crystals of the fatty acids and fibrinous casts of the bronchi are also frequently met with. The masses containing these can usually be distinguished by the naked eye as soft, yellowish, white plugs, varying in size from a millet seed to a bean, with a putrescent odour and smooth surface.¹ Elastic tissue may also be present.

The sputum in gangrene of the lung is characterised by its offensive odour, and grayish or greenish black colour—(a somewhat similar variety of expectoration is occasionally met with in fetid bronchitis, without bronchial dilatation, and between these two conditions it may be difficult to determine). It contains crystals of the fatty acids, and occasionally shreds of elastic tissue, which, however, may be destroyed from putrefactive (fermentative) processes. A tendency for the sputum to become purulent is a favourable omen, but this seldom happens. According to JUERGENSEN² it is not unusual for large portions of the lung to become gangrenous without the characteristic odour: this is apt to occur if the gangrenous area does not communicate with a bronchus.

Abscess, as well as gangrene of the lung, may be a sequel of croupous pneumonia. The expectoration in pulmonary abscess is characterised by consisting of pure pus of a grass-green colour, suddenly discharged, and generally more or less putrescent. Microscopically it consists of elastic tissue, pus

¹ (Traube) *Deutscher Archiv. für klin. Medicin* Bd. II., p. 488.

² *Ziemssen's Cyclopædia*, Vol. V., p. 130.

cells, blood corpuscles, fat crystals, and hosts of organisms. The pigment to which the greenish colour is due is distinguished from that of the bile by the nitrous acid tests.

Putrescent (stagnant) sputum is usually of slow development, and may originate in simple bronchitis, but is, as a rule, characteristic of bronchiectasis, pulmonary gangrene, and abscess. In bronchitis after diphtheria, the expectoration may assume a fetid odour, and simulate that met with in pulmonary gangrene. Fetid breath is usually an accompaniment of fetid expectoration, and occasionally the fœtor of the breath is of greater intensity than that of the sputum. It is extremely seldom that fetid sputum is witnessed in pulmonary phthisis, and hence its presence is almost sufficient to indicate the non-phthysical nature of a given case of pulmonary disease. The expectoration of phthisis of the lung is further distinguished by containing tubercle bacilli, which are never present in the class of diseases now under consideration : to this reference will again be made. Elastic tissue may be present in all these diseases ; it is usually, however, most abundant in phthisis, in which it also assumes its most characteristic alveolar arrangements and form. Putrid bronchitis and bronchiectasis are distinguished from each other by the character and manner of expectoration. The former is characterised by a frequent, easy cough, with scanty expectoration, whilst the latter is marked by severe fits of coughing, generally repeated at longer intervals, with copious putrescent sputa.

Fœtor of the sputum is usually of unfavourable prognosis in regard to complete recovery. Each case must be judged by itself with reference to the pathological condition inducing the fœtor, and the degree to which it interferes with the general health.

In the various forms of pneumonia other than the croupous variety (catarrhal, desquamative, and chronic interstitial), great importance ought to be attached to the examination and negative tubercular characters of the sputum. The naked-eye appearances are not decided : still, as in the case of bronchitis, it is a somewhat anxious circumstance to notice sanguineous sputa day after day, or at frequent intervals. The sputum is usually more or less purulent in character, sometimes scanty, usually profuse.

Microscopical examination reveals the presence of epithelial cells of various kinds, pavement, columnar, and alveolar, more seldom ciliated. The columnar and alveolar varieties are more frequently met with in this than in any other simple disease: their presence indicates a catarrh of the terminal bronchioles, and pulmonary alveoli, but certainly does not, as some maintain, mean the actual or threatened existence of tubercular disease (consumption). Elastic tissue may also be present, not only in shreds, but in well-marked leashes, as in the case of chronic pneumonia (Case 6). Fibrinous casts of the bronchi are absent, especially in chronic interstitial pneumonia.

In pneumonia from embolism (hæmorrhagic infarction) the following are the characters of the sputa according to JUERGENSEN,¹ "The expectoration is from dark-red to black in colour, and the blood which it contains is intimately mixed with tenacious mucus. It contains comparatively little air. An expectoration of this character may follow very soon after the entrance of an embolus, or some time may elapse before it appears. A characteristic point is that this expectoration continues for a considerable time; it may often be observed for a period of eight or ten days. The amount expectorated is ordinarily not very large. Embolism is soon followed by cough. If a catarrhal affection of the bronchi has preceded the accident, nothing can be made of this symptom. Inasmuch as the catarrhal affection is very likely thus to have pre-existed, the only advantage of the cough is that it facilitates the expulsion of the characteristic sputa."

In certain forms of these non-specific pneumonias and pleuro-pneumonias, in addition to the usual organisms which infest the sputum, a variety of schizomycetes is sometimes present, which, though apparently non-specific in character, appears to have some influence on the disease. Reference will hereafter be made to a variety which OERTEL has described as being peculiar to certain forms of rapid phthisis; the species, however, which I now bring forward has this peculiarity that it is seldom met with in tubercular cases, and further, those cases in which it occurs, though occasionally closely mimicking phthisis in their history, symptoms, and physical signs, do not

¹ Ziemssen's Cyclopædia, Vol. V., p. 256.

afterwards become tubercular. The following is the first case in which I detected these organisms.

CASE 1. Pleurisy with pulmonary inflammation; presence of schizomycetes and absence of tubercle bacilli from the sputum. Mr S., æt. twenty-six.—Suffers from pleurisy at base of right lung, with some concomitant pneumonia. Dr MAXWELL ROSS, his medical attendant, kindly sent me some sputum for examination on 9th December 1884. It was mucilaginous in character: contained pigment particles and numbers of alveolar epithelial cells, bronchiolar cells, and oil globules in the form of casts. It contained neither tubercle bacilli nor lung tissue, as shown on repeated examination by independent observers. Immense numbers of micro-organisms were present, as cocci, diplococci, and bacilli. These all retained the secondary stain on testing for tubercle bacilli, by EHRLICH's method, but they were rendered more apparent on using methyl violet as a single stain (Fig. 6). This sputum was kept until decomposition had set in, when it was re-examined with the result that the organisms had completely disappeared, and were replaced by the micrococci of putrefaction. The pneumo-coccus was not present. These organisms persisted in the expectoration until the patient's death in March 1885. Physical signs of cavity formation at the right base posteriorly, appeared about three weeks before death, and his condition at last was complicated by the development of pericarditis with general anasarca. Necropsy was refused. In its course and termination the case bore certain resemblances to those of fibroid phthisis, as described by Sir ANDREW CLARK.¹

The curious and interesting points in the case were, the persistence of these schizomycetes, their immense numbers, the comparative scantiness of the other elements of the sputum, and the non-development of tubercular disease. I have seen the same organisms in a low form of pneumonia and in bronchiolitis, and I am inclined to believe that they were also present in the sputum of the case reported on p. 15, an obscure form of pleuro-pneumonia coincident with hydro-thorax. I have rarely witnessed the presence of these organisms in some hundreds of preparations of tubercular sputa which I have stained and examined. Their distinguishing features are partly their forms and arrangement, but principally their immense numbers, and the extent to which they appear to outnumber the other elements of the sputum. They are capable of cultivation in the usual way, but legislative enactments prevented my testing their action on animals, though, as already stated, I do not believe they possess specific properties. Meantime I consider the

¹ British Medical Journal, 1885, Vol. I., p. 685.

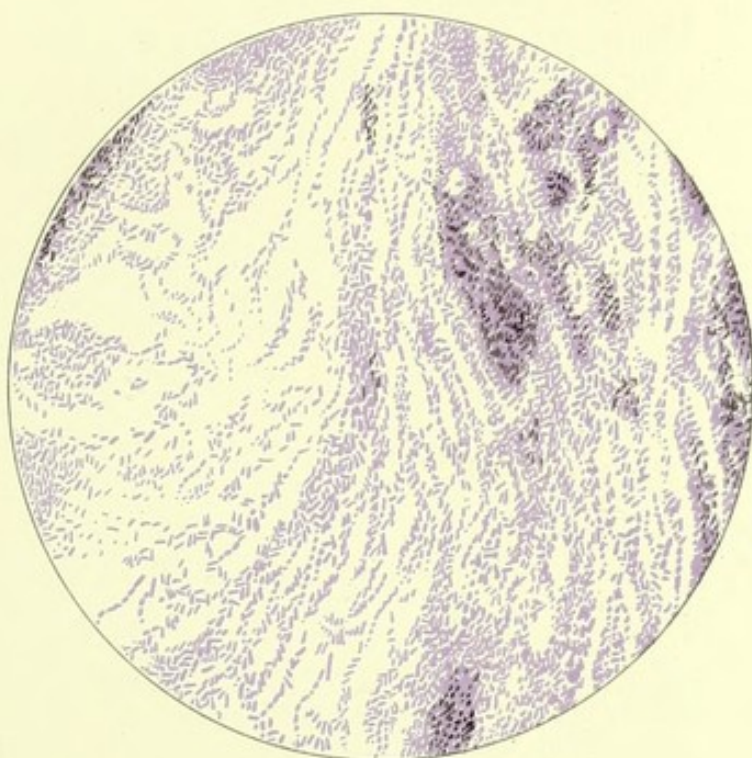


Fig. 6.—SCHIZOMYCETES FROM THE SPUTUM IN A CASE OF PLEURO-PNEUMONIA ($\times 350$, *Gentian Violet*)

W & J. K. Johnston Edinburgh & London.

presence of these schizomycetes in the sputum to be of favourable import, so far as regards the probability of the onset of tubercular disease.¹

An empyema which ruptures into the lung is characterised by a sudden and considerable increase in the amount of expectoration, which is purulent, and contains no elastic tissue. Casts of the minute bronchi may be present if bronchial and pleuritic inflammation co-exist.

The distinguishing feature of pulmonary hyperæmia and œdema is the copious expectoration of a frothy serous fluid, generally mixed with blood, and without bronchial casts.

¹ See Fig. 29, relating to a case of bacillary phthisis, in which the almost complete disappearance of the bacilli from the sputum was accompanied by the development of enormous numbers of the micro-organism now described and figured. See also Fig. 30, relating to a case of early phthisis, in which the disappearance of the bacilli from the sputum was accompanied by the presence of the filaments and spores of the *Leptothrix pulmonalis*.

CHAPTER III.

THE SPUTUM IN CROUPOUS PNEUMONIA AND IN ZYMOTIC DISEASES.

CROUPOUS PNEUMONIA belongs to what may be styled the specific group, the sputa of which are distinguished by the possession of certain characteristics, which not only separate them from those of the preceding (inflammatory) group, but also divide the individual members of this group from each other. These are partly of a macroscopic, but more particularly of a microscopic nature, and consist in the presence of organisms which, especially in the case of tubercle, in addition to being the causes of the diseases, are so constantly found in the sputum as to be of the greatest value in diagnosis.

The naked-eye characteristics of the sputum in croupous pneumonia are very marked and well-known; they vary according to the stage of the disease, and the age of the individual. At an early period (pulmonary engorgement) the sputum may be absent: when present it consists of a tenacious viscid fluid rich in mucine, and streaked with blood, except in the case of the aged, in whom it is frequently quite colourless. It floats readily in water. Its tenacity and viscosity are shown by the well-known test of inverting the sputum-receptacle without depriving it of any of its contents. In the next stage (pulmonary hepatisation) the sputum becomes more abundant, and of a deeper red colour from the greater and more intimate admixture of blood (rusty sputum). It is still tenacious and, containing less air than in the first stage, is more liable to sink in water. In the third stage (pulmonary resolution) the rusty tint becomes gradually less marked from the chemical action of the air upon the hæmatin of the blood, the expectoration increases in quantity, soon assumes a purulent, nummular character (*sputa cocta*), and consequently loses its viscosity. By-and-bye this purulent character is also lost, the sputum

assumes the character of simple catarrh, and finally completely disappears.

These characteristics of the sputum are so marked as to be pathognomonic of croupous pneumonia with a normal course. Instead of this, however, the disease may end in gangrene or abscess of the lung, or may terminate, before resolution has been accomplished, by exhaustion and pulmonary œdema, in which instances the sputum will assume the characters already described as diagnostic of these affections. The accompanying bronchial catarrh usually gives the sputum a more or less catarrhal character. In cases which terminate fatally the expectoration frequently entirely ceases.

During the course of a croupous pneumonia, should different areas of the lung be attacked in succession, the appearances presented by the sputa will deviate to a corresponding extent from those just described, and more particularly, the period of rusty sputum is apt to be more or less prolonged. Bronchiolar casts are usually present, and may be readily distinguished by examining the sputum in water. It seems uncertain whether these are formed from the fibrine of the inflammation, or from that of the blood.

In no other is the cycle of sputa-changes so marked or of so great diagnostic value as in this disease. More particularly is this the case in its earlier stages, before the development of well-marked physical signs: then the characters of the sputum alone are sufficient to indicate the probable nature of the disease. Occasionally, however, the typical expectoration is absent, owing, according to BUHL,¹ to the alveolar croup extending but a short distance beyond the infundibula. It is rare for excessive hæmorrhage to be present in croupous pneumonia.

The microscopical characters of the sputum in croupous pneumonia likewise possess some diagnostic value. In the first stage, mucus corpuscles with a few blood discs are the principal elements. The next stage is characterised by a freer admixture of more or less altered blood corpuscles, some mucus corpuscles, and a few alveolar epithelial cells. The third stage is marked by the disappearance of the blood discs, and an increase of pus-corpuscles, oil globules, fat cells, and young cells undergoing

¹ Quoted by Juergensen, Ziemssen's Cyclopædia, Vol. V., p. 90.

fatty degeneration. Fibrinous casts of the smaller bronchi are frequently present in adults during the second stage, though occasionally they are absent; they indicate the co-existence of a fibrinous or croupous bronchitis along with the pneumonia.

We owe to FRIEDLÄNDER the discovery of the micro-organism of croupous pneumonia,¹ the so-called pneumo-coccus. This is a more or less oval organism, fairly visible under a power of about 600 diameters, and usually possessing a distinct capsule, though occasionally without it. These cocci may be seen lying singly, but more frequently two of them are in close juxtaposition (diplococci) (Fig. 7); occasionally they are in chains, seldom in greater masses. They may be detected in croupous pneumonia as early as the characteristic (prune-juice) sputum appears, and they rapidly disappear on the subsidence of the disease.

The diagnostic value of organisms corresponding to the above description appears to be somewhat uncertain. FRIEDLÄNDER himself states that they possess no single microscopical characteristic which can be asserted to distinguish them from other organisms, and that, in determining the nature of these cocci, regard must be had not only to their microscopical characters, but also to their cultivation-appearances, and the result of their inoculation into animals. Their position in this respect would appear to be somewhat analogous to the comma bacillus of cholera (KOCH), which in addition to the microscopical requires also the cultivation test to separate it from other organisms.

Dr KLEIN has recently entered the lists against FRIEDLÄNDER in regard to the etiology of croupous pneumonia, and has published a report² on the subject. He acknowledges that the pneumo-cocci are freely present in the sputum of the disease, but asserts that they are septicaemic organisms, and are most abundant in sputum which has been allowed to stand for some time. Another organism, of an innocent nature, is also described by him as being present in the pneumonic sputum.

The mere presence of these so-called pneumo-cocci in the sputum would thus appear to be of doubtful value in the diagnosis of croupous pneumonia. It

¹ Virchow's Archiv. Band 87, xxxvii.

² Fourteenth Annual Report of the Local Government Board, 1885.

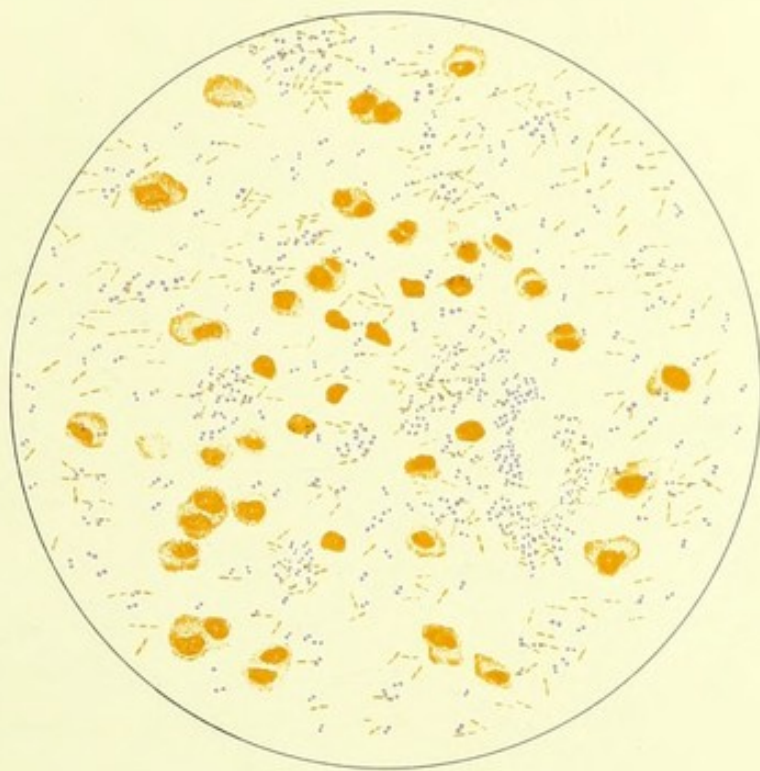


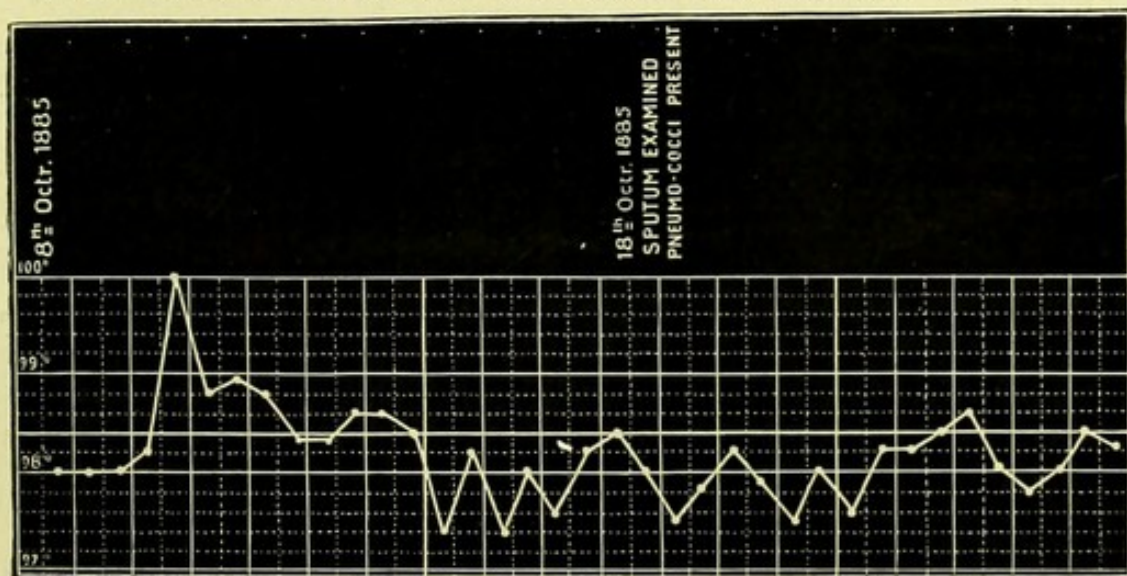
Fig. 7.—FROM THE SPUTUM IN A CASE OF CROUPOUS PNEUMONIA ($\times 580$).
Shewing pneumo-cocci, epithelial and pus cells, and bacillus subtilis. (Gram's Method:
Methyl violet and Vesuvín.)



seems an undoubted fact that they are not confined to this disease. The following is an example of a case which, neither in its symptoms, course, nor condition of the lung as indicated by the physical signs, was one of croupous pneumonia. The case was under the care of Dr AFFLECK, Physician to the Edinburgh Royal Infirmary, by whose permission it is here recorded at some length for the purpose of demonstrating that the so-called pneumo-cocci are met with in other lung affections than those bearing the clinical features of croupous pneumonia.

CASE 2. Hydrothorax with pulmonary congestion; presence of pneumo-cocci and schizomycetes in the sputum. Mrs B., æt. twenty-eight.—Admitted into the Edinburgh Royal Infirmary, on 8th October 1885. Her principal complaint was difficulty in breathing. The patient appeared to have exhausted herself from over-nursing. She had a cyanosed look; the pulse was 124, small, temperature normal. Over the lower portions of both lungs posteriorly, from the bases to the inferior angles of the scapulæ, there was dulness with complete absence of vocal fremitus, vocal resonance, and breath sounds. On the 18th (ten days after admission) the sputum was freely sanguineous, and mainly mucous. There were no tubercle bacilli present, but pneumo-cocci and abundance of schizomycetes (as described on p. 10) were present. The pulse was quiet (68) and the patient was improving rapidly. The abnormal physical signs over the lungs were also disappearing. The course of the temperature in this case is indicated by the following chart.

FIG. 8.—CHART SHOWING THE MORNING AND EVENING TEMPERATURE IN A CASE OF HYDROTHORAX, WITH PULMONARY HYPERÆMIA—PNEUMO-COCCI IN THE SPUTUM.



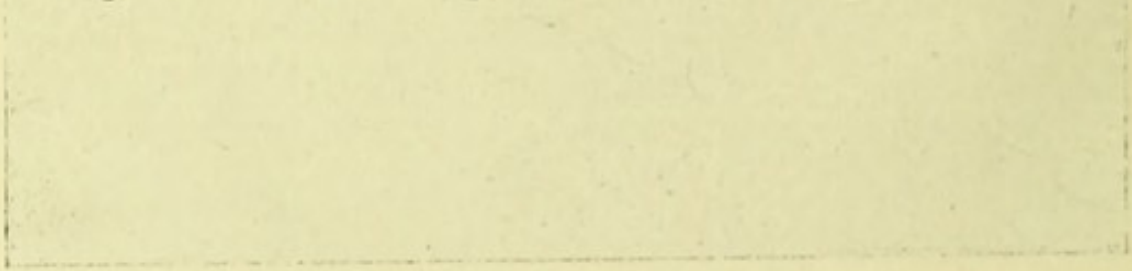
This case was diagnosed as one of hydrothorax, probably with some amount of pleurisy (pleuro-pneumonia?). The absence of

fever, as indicated by the temperature records, as well as the results of physical examinations of the lungs, clearly contra-indicated the existence of acute croupous pneumonia. The other organisms present appeared to be identical with those already described as being present in certain forms of inflammation of the lungs and pleura (p. 10).

Not only would it appear that the presence of the pneumococcus is not confined to the croupous form of pneumonia, but a similar organism may be detected in the sputum, without the co-existence of any variety whatever of pulmonary inflammation. Thus STERNBERG (quoted by KLEIN) states that a micro-organism corresponding in all essential particulars with that of FRIEDLÄNDER may be detected in human saliva, and that the inoculation of this in rabbits induces fatal septicaemia.

In view of these facts it appears that the naked-eye characters of the sputum in croupous pneumonia are of greater value in regard to diagnosis than are those which depend upon the microscope for their revelation. This statement must not be held as controverting the opinion that the disease depends upon, and is caused by, a specific micro-organism, but merely conveys the opinion that the microscopical characters of this organism have not as yet been so accurately differentiated, as to justify practical physicians in attributing much diagnostic value to its presence in the sputum.

The sputa of whooping-cough, and of the zymotic diseases have not as yet been shown to possess any pathognomonic macroscopic or microscopic appearances. Micrococci with no special characteristics have been met with in several of them. Should these diseases be complicated with pulmonary lesions, their sputa will, of course, present corresponding characters.



CHAPTER IV.

THE SPUTUM IN PHTHISIS OF THE LUNGS.

AS in the case of croupous pneumonia, the macroscopic characters of the phthisical sputum vary according to the stage of the disease, its mode of onset, and certain other circumstances which will now be shortly noticed. Any importance that may have been hitherto attached to the naked-eye appearance of the sputum in phthisis has been greatly diminished by the discovery of the micro-organism of the disease, and by the great diagnostic value which the presence or absence of this organism affords.

Phthisis may, or may not, be ushered in by the existence of a prodromal (tubercular?) catarrh. In the latter case there will be no cough or expectoration, or there may be cough without expectoration, sometimes lasting for months, especially in irritable or nervous individuals. Vomiting may accompany this cough. Should bronchial catarrh (broncho-pneumonia) be present, sputum of the usual catarrhal or bronchitic character will be present: it usually has a mucous or "mucilaginous" character, adheres to the bottom of the receptacle when this is inverted, and has occasionally a purulent streak throughout. This mucilaginous streaky character of the sputum is considered to be of evil omen, as indicating the existence of bronchiolar inflammation, and the probability of its terminating in phthisis. I have, however, frequently observed a glairy, mucous, streaky sputum present in cases of simple catarrh, which do not become phthisical. Persistent scanty sputa of the bronchitic variety constitutes the "sputum crudum" of the ancients, and is held to be characteristic of incipient phthisis.

During the period of softening, the sputum is usually still catarrhal in character, with or without the admixture of elastic

fibres, blood, or pus. According to GUTTMANN¹ the admixture of blood in reddish specks or streaks for a continued period, or frequently recurring, indicates the existence of chronic caseous infiltration and phthisis. By-and-bye, as the process of softening proceeds, the mucous expectoration becomes more decidedly muco-purulent, and then purulent, thus indicating the commencement of the third stage.

In well-marked phthisis with cavity-formation, the sputa assume certain well-known characters, becoming rounded and nummular, and, from their tendency to sink in water, were called by the ancients "*sputa globosa fundum petentia*." According to BIERMER, with whom I agree, typical nummular sputa may be also met with in simple chronic bronchitis. The presence of this sputum is certainly not diagnostic of cavity formation. Owing to the co-existence of bronchial catarrh, these sputa are usually mixed with a greater or less amount of mucus.

Generally speaking, therefore, it may be said that the character and amount of the sputum in phthisis depend upon the degree of implication or irritation of the bronchial or bronchiolar mucous membrane (especially of that of the larger bronchi), the extent and rapidity of cavity formation, the situation of such cavities in the lungs, and the nature and site of their communications with the bronchi. This latter is of special importance in regard to the difficulty or ease with which a cavity can be cleared of its contents. Cavities are in certain instances very tolerant of their contents, and only discharge the overflow: some are of an opposite character, being unable to tolerate the slightest accumulation of pus: others allow the discharge to accumulate, and then rid themselves of it entirely. The amount discharged is usually greatest in the morning, though changes of position at other times may also lead to a considerable amount of expectoration, by allowing the secretion to escape from cavities, and so to irritate the mucous membrane. It is seldom that the phthisical sputum becomes putrescent.

The so-called nervous cough is distinguished from that of tubercular disease by the absence of expectoration, by being generally continuous, by not being nocturnal, and by neither

¹ Handbook of Physical Diagnosis, New Sydenham Society, 1879, p. 200.

interfering with the general health, nor being accompanied nor followed by the development of physical signs of lung disease. The long continuance of a non-nervous dry cough is thought to be of bad omen, for in ordinary catarrh secretion and expectoration occur at a very early period. Cough may also be due to the mechanical pressure exercised by enlarged bronchial glands.

Cough unfavourably affects the prognosis in phthisis by inducing exhaustion, insomnia, and occasionally hæmoptysis. According to RUEHLE¹ "a very scanty expectoration, if the strength be well maintained, and the general condition satisfactory, has the same significance as a slight cough, under the circumstances, *i.e.*, it is rather favourable. In the later stages of the disease the sputum may be scanty, notwithstanding the progress of the malady. When the expectoration is more abundant, globular, and purulent, with diminution of the fever and improvement of the general condition, it indicates a limitation of the necrotic process by a simple cicatricial inflammation; this is favourable to the discharge of the necrosed portions of the tissues and of the exudation. If the sputa become offensive and contain products of decomposition, we may apprehend sloughing of the walls of the cavities, hæmorrhage, and an extension of the inflammation. An offensive purulent expectoration with black pigment and blood usually indicates the near approach of death." A curdy-looking sputum, as distinguished from a purulent one, is of bad prognosis.

The microscopical characters of the phthisical sputum may for practical purposes be considered under the headings of cellular, crystalline, fibrous, and parasitical.

The cellular elements present are those which we have already seen to be characteristic of bronchial and alveolar catarrh, namely, mucus, epithelium, pus, and blood. It has not yet been absolutely proved that, in the cellular elements of the phthisical sputum, any can be detected of a pathognomonic nature. The assertion, maintained by some observers, that the presence of alveolar epithelial cells in the sputum of individuals, at or over middle life, may be regarded as affording an indication of probable phthisis, seems to be rather of the nature of an hypothesis. These cells are frequently noted in the sputa of cases which are not,

¹ Ziemssen's Cyclopædia, Vol. V., p. 510.

and never become phthisical. GERMAIN SÉE, however, states that the presence of alveolar epithelium-cells in great quantity in the sputum acquires significance when coincident with catarrh of the superior lobes of the lungs (Fig. 9). If this be the case,—that the pre-phthisical (pre-bacillary) sputum possesses this characteristic feature,—the importance and prophylactic therapeutic value of the microscopical examination of the expectoration cannot be over-rated. Systematic observations relating to this important point are, however, still wanted.

Crystals of the fatty acids, if present in the sputum, are generally met with in advanced stages of the disease. They consist of palmitic and stearic acid, sometimes also of tyrosin. Their fan and needle-shaped arrangement is sufficient to distinguish them from elastic tissue; as also their solubility in alcoholic solutions of potash. These crystals require also to be distinguished from the bacilli of tubercle, for which see Chap. XIII. (Fig. 10).

Crystals of phosphates and chlorides are also frequently present in the phthisical sputum, usually synchronously with their appearance in the urine. Cholesterin and haematin crystals may occasionally be detected in cases which have been characterised by the occurrence of hæmorrhage. All the crystalline forms met with in the sputum have little diagnostic or prognostic value. It is essential for the observer, however, to be conversant with the fact of their occurrence, and with the forms assumed by them.

The most important of the fibrous elements of the phthisical sputum are the fibres of elastic tissue, usually found whenever ulceration of the lungs or larynx has taken place. Other varieties of fibres may also be present, as well as fungous filaments; these are, however, quite extraneous in character, and require to be recognised by the observer only on account of the liability of some of them to be mistaken for the more important elastic tissue fibres.

Unstriped muscular, or connective tissue fibres, fragments of bronchi, or of blood vessel may also be present in the advanced phthisical sputum.

The presence of elastic tissue fibres in the sputum

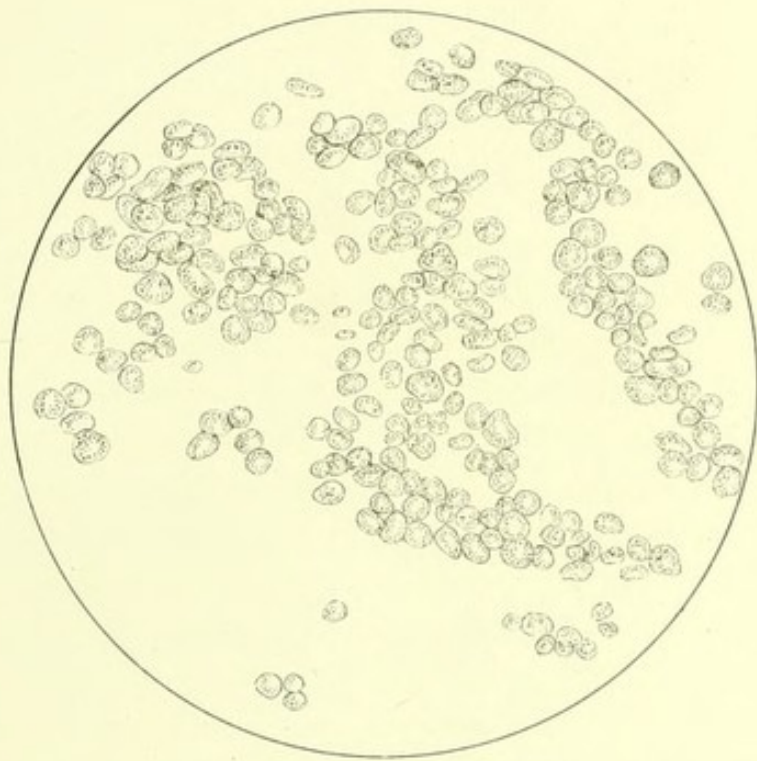


Fig. 9.—ALVEOLAR EPITHELIAL CELLS IN ABUNDANCE, FROM A CASE OF VERY EARLY PHTHISIS ($\times 300$). Tubercle bacilli and elastic tissue scantily present in the sputum. (Micro-photo-Lithograph).

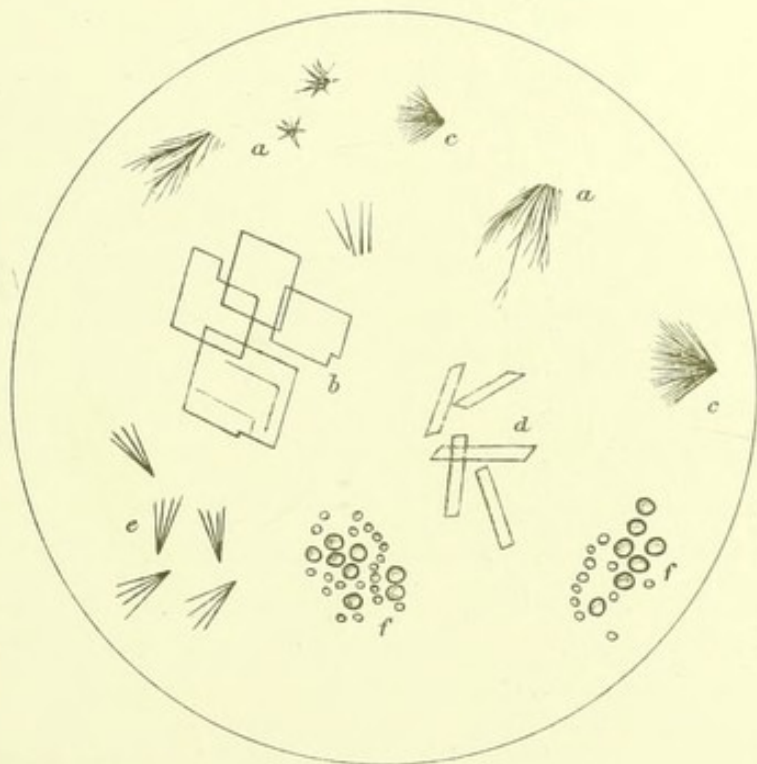


Fig. 10.—CRYSTALS FROM THE SPUTUM IN BRONCHITIS, BRONCHIECTASIS, AND PHTHISIS ($\times 350$).
a. Stearic acid ; b. Cholesterin ; c. Palmitic acid ; d. Hæmatin ; e. Tyrosin ; f. Oil globules.



has long been recognised, and, until within recent years, was considered the most important indication of its phthisical nature. NIEMEYER has very strong views in regard to the diagnostic value of their presence, for he states,¹ "the discovery of such elastic fibres is a sure sign of phthisis." Other authors have attributed almost equal importance to its presence, as for instance GUTTMANN,² who states that "the presence of elastic fibres may generally be regarded as diagnostic of phthisical disorganisation of the lungs, phthisis being the most common of the pulmonary diseases leading to destruction of tissue. Lung-tissue, however, occurs also in the sputum in cases of pulmonary abscess, of ulceration of the bronchi, and of bronchiectasis, but not, or only for a very short time and in small quantity, in cases of gangrene of the lungs."

The elastic tissue of the sputum may be derived from the lungs or the larynx, and is said to present certain characteristics according to its locality of origin. The pulmonary variety may proceed from the bronchial walls or from those of the alveoli. That from the bronchi is devoid of the well-marked alveolar arrangement which generally distinguishes that from the alveoli. The laryngeal variety is also free from alveolar arrangement, and is arranged more in the form of interlacing fibres or of wavy threads. The amount present may form mere shreds or, on the other hand, in cases with large cavities, extensive leases occupying the whole field of the microscope (Figs. 11 and 12).

The presence of this tissue in the sputum, whilst almost universally met with in phthisis, cannot be held to be pathognomonic of the disease. It simply indicates that ulceration is in progress, but while it assists in indicating the locality, it gives little assistance in determining the cause. As its presence is still considered by some to be indicative of tubercular disease, I have deemed it fitting to submit short notes of the following as examples of non-phthisical cases, in which this tissue was demonstrated in the sputum.

CASE 3. Chronic bronchitis: elastic tissue in the sputum. Mrs B., æt. forty-seven, 13th May 1884.—Chronic bronchitis (bronchiectasis?), from which she had suffered for the last sixteen years. Bronchitic sounds over chest, with a few coarse crepitant râles at left apex anteriorly, p. 86.

¹ Text Book of Practical Medicine, Revised Edition, p. 227.

² Handbook of Physical Diagnosis, p. 179.

Sputum muco-purulent, sanguineous, with no bacilli of tubercle. 1885, Feb. 2.—Bronchitis continues: sputum muco-purulent: no bacilli, but shreds of lung tissue undoubtedly present.

CASE 4. Simple catarrh: elastic tissue in the sputum. Mrs H., æt. twenty-five, 15th November 1884.—Commencing to cough and expectorate. Physical signs *nil*. Sputum muco-purulent, containing no bacilli, but a small amount of pulmonary elastic tissue. 10th April 1885.—Patient now quite well, and free from cough; no development of chest signs occurred.

CASE 5. Chronic laryngitis: elastic tissue in the sputum. Mr M., 8th November 1884.—Complains of hoarseness, with slight pain on right side of throat, especially on deglutition, of a few weeks' duration. On laryngoscopic examination, the right ventricular band is swollen and of a bright red colour; the corresponding arytenoid cartilage is also more prominent than usual, and its movements are impaired. No fever. Chest perfectly normal, as ascertained by Dr MAXWELL ROSS and myself. Sputum mucous, slightly sanguineous: contains a few pus cells, no bacilli of tubercle (six preparations) but undoubted pieces of elastic tissue. 1884, Nov. 18.—Chest still normal: larynx presents the appearance of œdematous laryngitis, with a swollen and inflamed epiglottis, and slight ulceration. 1885, Feb. 10.—Throat rather painful, especially on left side: epiglottis swollen and red, closely applied to retro-pharyngeal wall, and twisted on its vertical axis. Chest normal, sputum mucous, with whitish streaks and masses throughout. No certain elastic tissue detected. 1885, Oct. 4.—Chest still normal. No pain in swallowing; but persistent pain at other times on left side of neck, and in left ear. Voice whisperingly aphonic: epiglottis bright red, and by its swelling and twisting, obscuring a view of the interior of the larynx. Inspiratory dyspnœa. Well-marked leashes of laryngeal elastic tissue present (Fig. 20): no tubercle bacilli. 1885, Nov. 10.—Pain gone: and epiglottis less red and swollen. Patient, who has never left off work on account of his illness, feels very well, with no laryngeal uneasiness or trouble. Has now no expectoration whatever.

CASE 6. Chronic pneumonia in a syphilitic subject: elastic tissue in the sputum. Mr B., æt. forty-five, 1st October 1884.—Complained of a sudden and severe hæmorrhage on the previous evening. Had epistaxis about a week previously, and the morning sputa were occasionally tinged with blood during the summer months. Had syphilis about ten years previously. At 4.30 p.m.—Pulse 110, rather full. Temp. 99.2. Nothing detected in lungs, beyond a little jerkiness of breath sounds. Cardiac sounds impure, and undefined. Sputum scanty, purulent, sanguineous: no bacilli on repeated examinations, but shreds of lung tissue are freely present. 21st Oct.—Hæmorrhage has slightly recurred: sputum still free from bacilli. It contained shreds of elastic tissue, and great masses of spores, thalli, and mycelium of a fungus (*Penicillium glaucum*), pigmented pulmonary alveolar epithelial cells, and fibrinous bronchiolar casts. 10th Nov.—Another slight recurrence of bleeding: no bacilli: lung tissue present: occasional slight crackle on inspiration over left lung posteriorly. 27th Dec.—Recurrence of



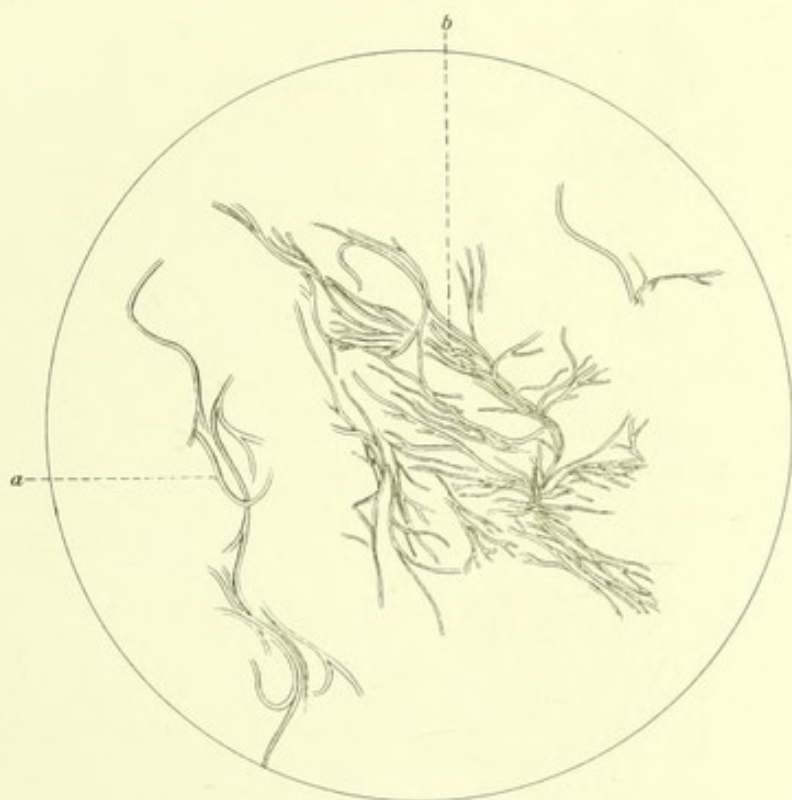


Fig. 11.—SHREDS OF ELASTIC TISSUE FROM THE SPUTUM ($\times 300$).
a. Pulmonary ; *b.* Laryngeal.





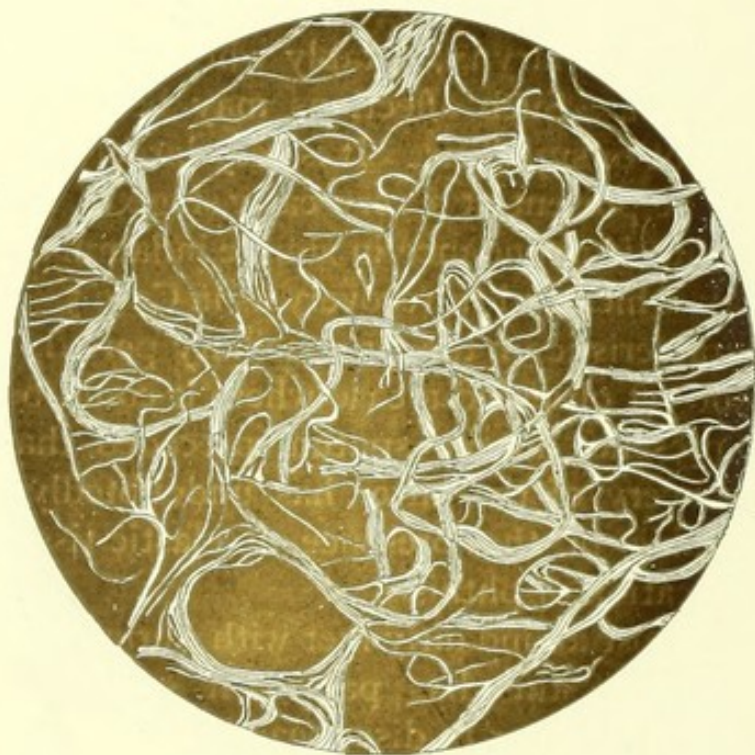


Fig. 12.—PULMONARY ELASTIC TISSUE FROM THE SPUTUM IN A CASE OF CHRONIC BACILLARY
PHTHISIS (Micro-photo-Lithograph $\times 300$).

The preparation extended through several fields of the microscope.

bleeding. (The patient passed at this time from under observation, but on enquiry about nine months afterwards, it was ascertained that he had developed a pneumonia, chronic or syphilitic, of the right pulmonary base, but tubercular disease had not supervened.)

The presence of elastic tissue, even with an alveolar arrangement, in the sputum, does not thus necessarily indicate the existence of tubercular disease of the larynx or lungs. It may be met with in chronic bronchitis, bronchiectasis, chronic pneumonia (Case 6), pulmonary abscess, and in certain affections of the larynx, notably where the epiglottis is undergoing ulceration. Such affections may be inflammatory, tubercular, malignant or syphilitic. It is very largely met with in phthisis, and may be present at a very early stage of the disease, but may be met with in abundance in simple inflammatory affections of the larynx, which end in recovery as in Case 5. Whether it may be a characteristic of the pre-bacillary period, I cannot say, for I have not yet observed a case where it could be demonstrated that its presence in the sputum preceded that of the bacilli. The discovery of the latter has undoubtedly lessened the diagnostic value of the presence of elastic tissue in the sputum, as an indication of phthisis.

Elastic tissue is most abundantly met with during the stage of cavity-formation: when this has passed, it seems to become greatly reduced, or altogether to disappear (see Case 21).

Altogether, its value in diagnosis is comparatively slight, and its presence in the sputum can be regarded now as little more than an indication of pulmonary or laryngeal ulceration which may have arisen from various causes, and from which recovery may take place.

CHAPTER V.

THE SPUTUM IN PHTHISIS OF THE LUNGS—CONTINUED.

THE sputum in phthisis is thus seen to be composed of various elements which, on account of their liability to be present in non-phthisical cases, have small diagnostic significance or value. It cannot, for example, be asserted that the presence of any, or all, of the varieties of epithelial cells lining the respiratory passages, or even that of yellow elastic tissue, can justify, without other support, a diagnosis of pulmonary phthisis. By his discovery of a micro-organism peculiar to the disease, and which can almost constantly be detected in the expectoration of phthisical patients, KOCH has made the work of sputum-examination as incumbent upon the physician, and as important, as that of examining the chest by percussion and auscultation. Greater importance, indeed, may be attributed to sputum-examination in lung disease than to the ordinary methods of judging from physical signs only. The deductions drawn from the latter are generally conjectural, and frequently fallacious, and, in the present day, unless they be supplemented by the sputum-tests, cannot be accepted with perfect confidence.

The tubercle-bacillus, first described by KOCH,¹ belongs to the group of *Desmobacteria*. It is a rod-shaped body of varied length, breadth, and outline, the average size of which is about one-half the diameter of a red-blood corpuscle. These rod-like bodies are found singly, or in bundles (faggots); or by two or more combining in end-to-end arrangement, a great variety of complex forms may be developed, as in Fig. 13. They may be counted by units or by hundreds in the field of the microscope, while occasionally they are so densely massed as to obscure a part or the whole of the field. They may alone occupy the field of the

¹ Berliner klinische Wochenschrift, xv., 1882.

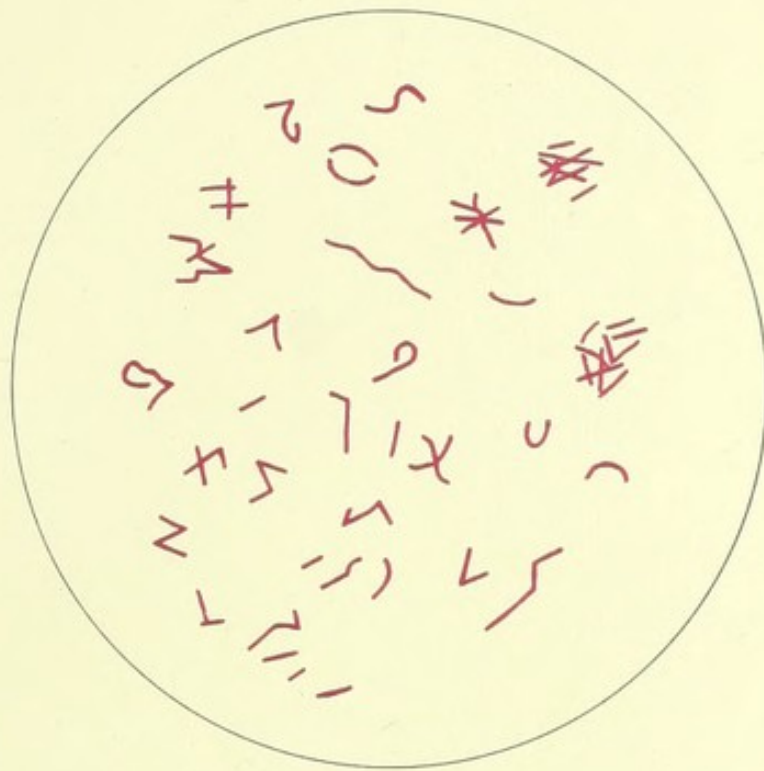


Fig. 13.—DIAGRAMMATIC REPRESENTATION OF THE FORMS ASSUMED BY THE BACILLI OF TUBERCLE (*Magenta*).

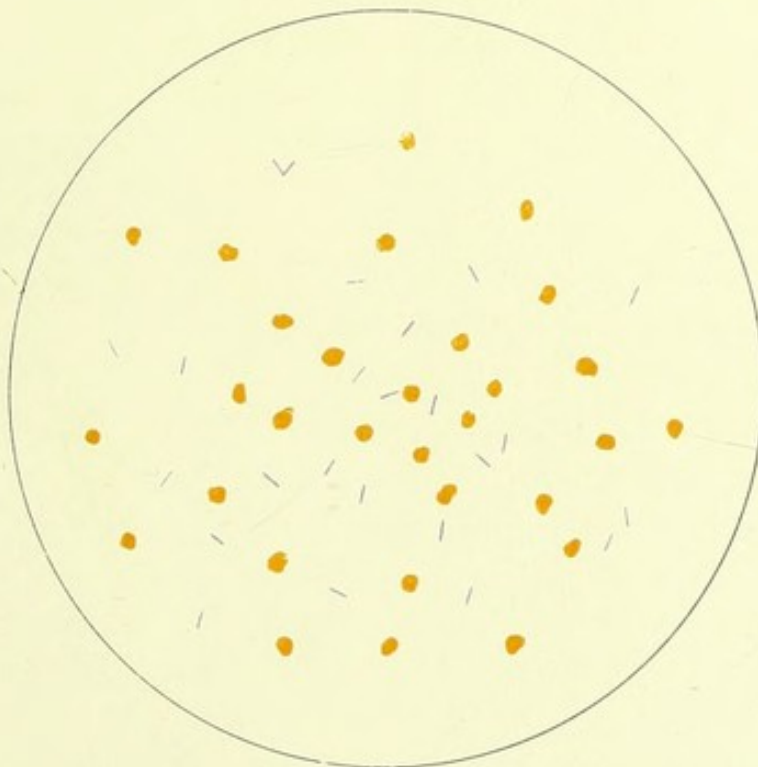


Fig. 14.—BACILLI OF TUBERCLE AND PUS CELLS OF THE SPUTUM ($\times 350$, Gram's Method : *Methyl violet and Vesuvin*).



microscope, but more frequently they are interspersed amongst the cellular elements of the sputum, which latter are readily distinguished by the contrast stain. They are not distributed equally throughout the sputum, but are more likely to be found in the purulent than in the mucous portion, and in the deposits which take place to the bottom or sides of a conical glass. A purely mucous sputum may, however, be crowded with them, as in some cases of acute phthisis. When the sputum is of a watery mucoid consistence, the bacilli on staining are usually seen embedded in a granular matrix. It is interesting to note that elastic tissue never appears after staining for tubercle bacilli.

In the consideration of the value of the bacillus of tubercle in the diagnosis of tubercular disease of the throat and lungs, it appears necessary to determine the relationship of this organism—(1) To non-tubercular diseases; (2) To early phthisis; (3) To advanced phthisis; (4) To the other constituents of the phthisical sputum.

1. The relation of the tubercle bacillus to non-tubercular diseases.—I may here state that, after careful repeated examinations of the sputa of pulmonary diseases other than tubercular, I have never been able to find in them any trace of tubercle bacilli. The evidence of this by other observers is so ample, that little more need be said here except the simple affirmation that the tubercle bacillus is never present in the sputa of non-tubercular diseases.

The negative results obtained in non-tubercular diseases, but with certain elements of suspicion in their character, are amongst the most valuable, as they are amongst the most difficult of attainment. For a negative observation, in order to carry due weight, must be the result of repeated examinations of the sputum by experienced and careful observers. Negative conclusions may be arrived at owing to the absence of the bacilli, or bacilli may be present and not detected, owing to a faulty method of staining (see Chapter on staining), or to an inacquaintance with the conditions which govern the presence of the bacilli in the sputum, and to which reference will again be made. Observations have shown that it is extremely rare for bacilli to be present in the lungs, and

absent from the sputum, on repeated examinations by experienced observers. This may occur, however, as in fibroid phthisis.

The diseases in which negative observations are of value are such as simple apical catarrh, syphilis of the lung, chronic pleurisy, simple chronic pneumonia with or without crepitation at the apices, pulmonary hæmorrhage, bronchiectasis, etc. The following are illustrations of the cases in which I have found negative observations to be of service.

CASE 7. Pseudo-phthisis: no bacilli: recovery. Mr C., æt. forty-three, in April 1883, had several of the general symptoms of phthisis, such as loss of weight, rigors, and night-sweats. Pulse 100, soft. Expiration slightly prolonged at right apex. Voice hoarse. Reddening of vocal cords, with a granular projection about the centre of right cord. The sputum was mainly mucous, with a little muco-pus throughout. No tubercle bacilli, after repeated examination. 1885, Nov. 4.—The patient still continues free from tubercular disease.

CASE 8. Pseudo-phthisis: no bacilli: recovery. Miss B., æt. thirty-four, 12th Sept. 1883.—Complains of cough, scanty expectoration, and slight hæmoptysis. Neither rigors nor night-sweats. Dry scrape at end of inspiration at left apex anteriorly, with slightly prolonged expiration, and slight comparative dulness. Temp. at 2 p.m. 99·2. Pulse 110. Sputum purulent, scanty, containing no tubercle bacilli. 28th April 1884. Pulse 120, slight squeaky sounds on coughing at both pulmonary apices, but no moist sounds. No tubercle bacilli in sputum. Has been pretty well all the winter, and has not developed phthisis.

CASE 9. Pseudo-phthisis: no bacilli: recovery. Mr M'D., æt. twenty-three, 31st March 1884.—Complains of cough and night-sweats. Temp. usually rises during the afternoon to about 100°. Slight comparative dulness at right infra-clavicular region, with a dryish click on inspiration, and prolonged expiration. Sputum dark glairy mucus, with mucous pellets throughout, and a frothy surface: it contained no tubercle bacilli. 1885, January.—The patient is now, and has been during the whole of the winter, quite well, and free from any suspicion of tubercular disease.

These cases illustrate the value of the absence of the bacillus from the sputum in the diagnosis of pulmonary disease, and the assistance which it affords the practitioner in separating simple from tubercular apical catarrh. For it is in these suspicious and doubtful cases that its presence or absence is of the greatest value. Amongst the non-tubercular pulmonary diseases in which negative observations of the bacillus are also of service are those characterised by hæmorrhage. The term is here used, not to indicate a mere tinging of the sputum,

but a flow of almost pure blood, sometimes to the extent of one or more mouthfuls, generally repeated, and gradual in its cessation. Hæmorrhage has been long, and still is, a well-recognised symptom of early phthisis, for, says LOUIS "grave hæmorrhages without tubercle are rare." However, it is an undoubted fact that an alarming hæmorrhage of pulmonary origin may occur, without being preceded or followed by tubercle. This is illustrated by the following cases.

CASE 10. Chronic pneumonia (syphilitic): no tubercle bacilli in sputum. Mr B., æt. forty-five, 1st Oct. 1884.—(This case is reported on p. 22. It was distinguished by frequent hæmorrhages, slight fever, non-bacillary sputum, as shown on repeated examination. It terminated in chronic or syphilitic pneumonia of the base of lung.)

CASE 11. Pulmonary hæmorrhage, probably cardiac: no bacilli: recovery. Mr H., æt. twenty-five, 11th Sept. 1883.—Pulmonary hæmorrhage, of which he had had three attacks during the preceding two years. At noon pulse quiet. Temp. 98·4. Respiration louder at left than at right apex, markedly interrupted with occasional rough crepitus: 2nd cardiac sound accentuated and reduplicated at pulmonary area: 1st cardiac sound exaggerated at mitral area. Sputum sanguineous, muco-purulent: no bacilli present. (Two years subsequently, this patient is quite well.)

I have had occasion to note in other hæmorrhagic cases, the extreme diagnostic and prognostic value attached to negative results of sputa examinations. In these, the absence of tubercle bacilli warranted a diagnosis of non-tubercular disease, a result which in most cases could not have been arrived at by a consideration of the physical signs and symptoms alone. Further reference to the question of hæmorrhage in the sputum is made in Chapter VIII.

In addition to the classes of apical catarrh, and of hæmorrhage, negative results of sputa examinations are of service in separating simple chronic pneumonia (Case 6) and bronchiectasis from phthisis, in differentiating syphilitic from tubercular disease of the lungs, and chronic pleurisy from chronic phthisis. The negative characters of the sputum in chronic pleurisy is illustrated by the following case:—

CASE 12. Pleurisy: empyema rupturing into bronchi: no tubercle bacilli in sputum. Mr B., æt. twenty-six, 13th June 1885.—Complains of weakness, shortness of breath, and cough. Had pleurisy about two years previously, and has never been quite well since. Morning, pulse 84, temp. 98·9. Dulness over the lower half of left lung, with absence of

breath-sounds, and vocal fremitus. Sputum muco-purulent : no bacilli, but numbers of non-pathogenic organisms (see p. 10). 24th July 1885.—Since last report, patient has expectorated largely : breathing is now more audible over the affected area. Sputum abundant, purulent. No lung tissue nor tubercle bacilli present, but abundance of bronchiolar casts. 13th Nov. 1885.—Very much improved. (An empyema had apparently ruptured and discharged itself into the bronchi.)

It cannot be denied that in such a case it is reassuring, even with the physical signs well marked, to find that the sputum contra-indicates the presence of tubercular disease. For one can never be certain as to what underlies, or may result from, a chronic pleurisy. A so-called tubercular pleurisy, unless, as frequently happens, a similar affection of the lung co-exist, is not characterised by bacillary sputum, nor can bacilli be detected in the pleural fluid. One of the most interesting and instructive examples of an apparently simple inflammatory case mimicking tubercular disease is afforded by the following, for opportunities of observing which I am indebted to Dr HENRY HAY.

CASE 13. Bronchiolitis mimicking phthisis : no tubercle bacilli in sputum. Mr M'C., æt. thirty-eight, 15th March 1885.—Complains of weakness, cough, and emaciation. At 11 a.m., pulse 112, soft, temp. normal. On auscultation, respiration is heard somewhat roughened, with a tendency to crackling at the left apex posteriorly, but no appreciable dulness on percussion. Sputum thick and lumpy. It contained neither bacilli, elastic tissue, nor other organisms, on repeated examinations on separate days. 1885, April 7th.—Sputum mucous, with purulent masses throughout. Neither bacilli nor tissue present, but abundance of epithelial cells, alveolar and others. April 17th, 2 p.m., pulse 128, soft. Expiration prolonged at both apices, with a scraping sound at end of expiration at right apex, less so at left. Observations of the temperature were taken by Dr HAY with two thermometers, at hours from 6 to 10 p.m., with a normal, or slightly subnormal result. Pulse on these occasions usually about 100. 10th Sept. 1885.—Sputum still free from bacilli and tissue, as determined by two independent observers. Patient is still thin, and though complaining of weakness, is able to discharge the work of a small shopkeeper.

The interesting and instructive points in this case are, the equivocal character of the physical signs, the phthisical nature of the general symptoms, and the rapidity and softness of the pulse. A consideration of these alone, without regard to the character of the sputum, and, be it noted, to the state of the temperature, pointed towards phthisis, and as a fact induced more than one

medical man to this diagnosis. The condition present was apparently one of inflammation of the minute bronchioles and alveoli, as evidenced by the presence of bronchiolar casts and abundant alveolar and columnar epithelial cells in the sputum. It is perfectly certain that the patient was free from tubercular disease, but whether this may not eventually supervene on the existent inflammatory (pre-bacillary?) affection, time alone can determine.

The relation of the tubercle bacillus to the sputa of non-tubercular pulmonary diseases is thus of an absolutely negative character. It has never been detected in them, and were we as certain of its presence in the sputa of early phthisis as we assuredly are of its absence in non-phthisical cases, we should have arrived at an invaluable aid in diagnosis. This point I shall now proceed to attempt to assist in determining.

2. The relation of the tubercle bacillus to early phthisis.—If the teaching of KOCH as to the part played by the bacillus in the etiology of tubercle be accepted, that, in the words of KLEIN, there is “no bacillus without tubercle, and no tubercle without bacillus,” this organism must necessarily be present from the very inception of the disease. The important point to determine is, is the bacillus present “*ab initio*,” or is there in all or some cases a condition of preliminary alveolar catarrh, by which the pulmonary soil is prepared for the reception and growth of the organism? Is the presence of the bacillus a scientific means of anticipating the development of the physical signs and general symptoms of early phthisis, or does the organism appear only after these have become well pronounced?

Here it must be confessed that the doctrine of pre-disposition (receptivity) forces itself into prominence, for it is only by its adoption that an explanation can be afforded of the apparently capricious nature of the attacks of the bacillus. This pre-disposition may be constitutional or local, the former preferably. For it is a matter of everyday observation that many individuals, who suffer from periodic attacks of pulmonary inflammation, especially the so-called winter catarrh, live for years without exhibiting any tendency to tubercular disease, whilst on the

other hand, a slight cold in one phthisically pre-disposed, suffices to open the doors of the system to the bacillus.

But be this as it may, the important question to determine is, the chronological sequence of the appearance of the bacillus, the onset of the general symptoms, and the development of the physical signs. It is important to notice that the determination of this question may be frustrated by the complete absence of expectoration with or without cough in the earlier stages of the disease, and consequently, by the absence of opportunities for detecting the bacilli, which, however, may yet be present in the lung. This occurs but seldom, and then only in very acute cases, such as the following :—

CASE 14. Acute pulmonary phthisis without cough or expectoration. Miss M., æt. seventeen, 24th Feb. 1884.—General symptoms prostration, emaciation, fever (evening temp. 101·6; pulse, 136, soft). Local signs, rough respiration, prolonged expiration, and dry scraping sound on inspiration at right apex anteriorly, slightly so posteriorly. No cough or expectoration. An attempt was made to detect bacilli in the breath of the patient, but with negative results. A few days subsequently, the patient passed from under observation, no expectoration having meanwhile occurred. She died of acute pulmonary phthisis ten weeks subsequently.

This case affords an opportunity for directing attention to the fact as above stated, that in the absence of expectoration, I have hitherto been unable to detect pulmonary bacilli in any other media, such as the expired air of the patient. I have made various attempts in this direction, by causing phthisical patients to expire into flasks surrounded by ice, as first carried out by RANSOME, and have been unable in any one instance to confirm the results obtained by that observer. Besides, this method is so cumbersome, and would be so unpracticable by the mass of the profession that, even if successful, it could never come within the range of practical medicine. “No sputum, no bacillus,” is the axiom which I consequently feel justified in submitting in the case of pulmonary tuberculosis.

Amongst the most important of the general symptoms of early phthisis are fever, loss of weight, and cough. These may, and often do, anticipate the development of unequivocal physical signs, and their diagnostic relationship is frequently ambiguous. It is at this period of the disease, when probably only one of these symptoms has developed, that the bacillary

test is of real service, as in the following series of cases which I now briefly describe :—

CASE 15. Incipient bacillary phthisis without fever: recovery. Mrs E., æt. twenty-eight, 14th August 1885.—The only complaint in this case is cough. Pulse quiet: temp. normal. A slight inspiratory click at right apex anteriorly. Sputum consists of clear mucus, with lumpy purulent masses throughout. Patient's husband suffers from bacillary phthisis. Bacilli present, only one or two in the field. Very small shred of pulmonary elastic tissue also found. 24th August.—Sputum purulent: one or two bacilli found by two observers in whole preparation: no tissue. Pulse 64, temp. normal. 1st December 1885.—Sputum very scanty, entirely mucous, with no bacilli after repeated examinations. Menstruation, which had ceased at last report, has now returned, and patient feels very well. Pulse 64, quiet. Treatment.—Abundance of fresh air, abstention from all vegetables, and separation by night from her phthisical husband.

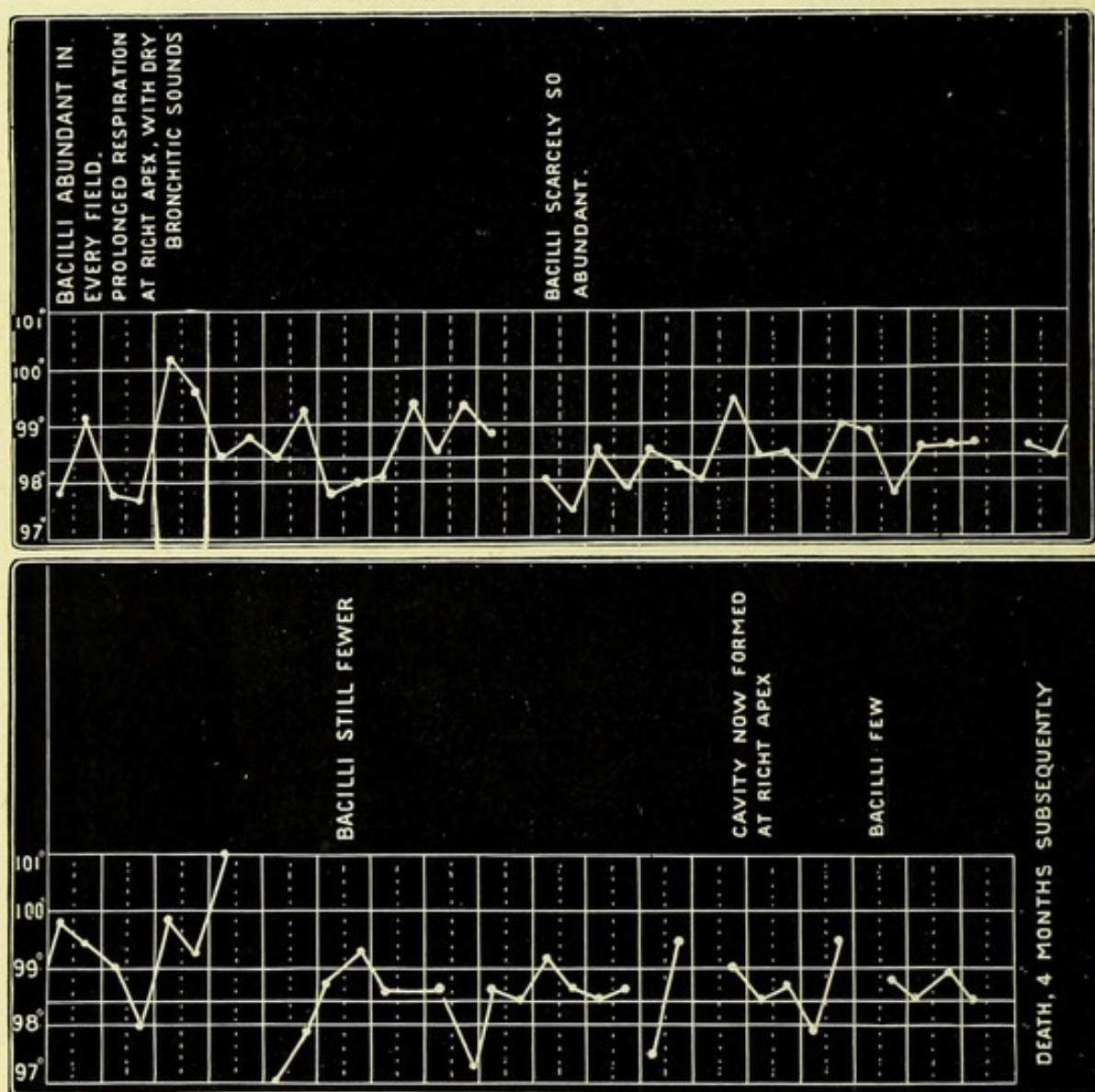
CASE 16. Incipient bacillary phthisis without fever: slight hæmorrhage: recovery. Miss W., æt. twenty-five, 20th July 1885.—Complains of slight occasional hoarseness and cough. Thin and anaemic. Nothing definite in chest: congestion of larynx. Sputum has been lately streaked with blood: it is now scanty and muco-purulent. Two or three bacilli seen by two observers in the field of the microscope. No elastic tissue present. 4th August.—3 p.m. temp. 98·2. Pulse 84, rather full. Blowing murmur on inspiration at left apex. Has occasional rigors. Sputum scanty, thick, purulent: bacilli as formerly, and one distinct shred of elastic tissue present. 1885, 5th Dec.—Sputum mucous with very small purulent streaks throughout; no bacilli in five preparations. The purulent streaks consist mainly of immense numbers of a fungus (*leptothrix*), in the active sporiferous stage (Fig. 30). Patient is well and has no complaint of any kind. Treatment.—Residence in country, abstention from all vegetables, milk in abundance.

CASE 17. Bacillary phthisis: no fever during early stages. Mr M., æt. thirty-eight, 30th Nov. 1883.—Complains of a racking cough. Medical attendant reports no distinct physical signs, and no fever. Sputum purulent, bacilli present, not generally throughout preparation, but in a limited area only. 1885, May.—This patient has now developed undoubted pulmonary consumption, with fever, etc.

CASE 18. Bacillary phthisis: no fever and equivocal physical signs during early stages. Mrs R., æt. forty-five, 3rd Sept. 1884.—Has had a cough since the commencement of spring: this has become rather worse of late, and her general health is deteriorating. Nothing very decided in chest. Over the right apex is a small area where the breathing is of a jerky character, with some increase of vocal resonance. Sputum purulent, bacilli present, not uniformly throughout the preparation, but mainly in one spot. 1885, 24th April.—Has had a hæmorrhage to the extent of two tablespoonfuls, followed by slight fever. The physician

in attendance (in the Riviera) can find "nothing definitely wrong in the chest," and thinks the hæmorrhage a "forerunner of tubercular disease" (*sic*). 1885, Oct. 8th.—Bacilli now present to the number of 100–150 in the field of the microscope. Has had a return of the hæmorrhage, to the extent of about two or three tablespoonfuls. Temp. 98.4, pulse 88, weak, regular: air entering fairly well into right lung; there is no dulness or crepitation present. At left apex in front there is high-pitched jerky respiration, with slightly impaired resonance. 8th Sept.—All the bad symptoms have disappeared.

FIG. 15.—CHART SHOWING THE MORNING AND EVENING TEMPERATURE IN A CASE OF SUB-ACUTE BACILLARY PHTHISIS—Patient *æt.* FIFTY-NINE.



CASE 19. Bacillary phthisis without fever or recognisable physical signs. Mr H., *æt.* twenty, 9th Aug. 1884.—Complains of occasional wheezing respiration, and rough cough. Had two hæmorrhages during the preceding winter. Pulse 70, temp. normal. Nothing abnormal in chest after very careful examination. Sputum muco-purulent, with bacilli to the

extent of twenty to thirty in the field. Shreds of elastic tissue also present. (This patient subsequently developed well-marked phthisis.)

These cases may be considered as typically illustrative of the class in which the presence of bacilli in the sputum is of true diagnostic value, for in none of them were the physical signs and symptoms sufficiently pronounced to warrant a diagnosis of pulmonary tuberculosis. In Cases 15 and 16, the discovery of the bacillus at apparently very early stages afforded indications for the successful institution of such hygienic and dietetic measures as tended towards recovery.

The relation of the bacillus to the symptom of fever, as represented by a consideration of the pulse and temperature, is of importance, especially in regard to the diagnosis of early phthisis. Is the bacillary presence always indicated by fever, and is the thermometer of any utility in its detection? A reference to the cases just recorded will indicate that complete, or almost complete, absence of fever symptoms was amongst their most prominent features. The temperature chart (Fig. 15), and table now appended, will further illustrate this point.

TABLE SHOWING THE EVENING TEMPERATURE IN A CASE, ÆT. TWELVE, OF SLOW BACILLARY PHTHISIS. DISEASE COMMENCED IN MIDSUMMER, 1882, WITH HÆMORRHAGE, APICAL DULNESS, AND SLIGHT CREPITUS.

1883.			
September	25th	Temperature at 8 P.M.	99·2
"	29th	" "	98·4
"	30th	" "	97·4
October	2nd	" "	98·0
"	3rd	" "	98·4
"	4th	" "	98·9
"	5th	" "	98·4
"	6th	" "	99·1
"	7th	" "	98·1 (at 8 a.m. Temp. 98·1)
"	8th	" "	98·1 (at 8 a.m. Temp. 98·2)
"	9th	" "	98·6
"	14th	" "	98·4
"	15th	" "	98·8
"	16th	" "	98·0
"	18th	" "	98·4 (at 5.30 p.m. Temp. 98·7)
"	19th	" "	98·0 (at 6.30 p.m. Temp. 99·2)
"	20th	" "	98·0 (at 6.20 p.m. Temp. 98·8)
"	21st	" "	97·5 (at 6 p.m. Temp. 98·7)
"	22nd	Temperature at 8 A.M.	98·0

During the period of observation bacilli were readily found in the sputum in fair abundance: the patient was increasing in weight (4 lbs. in six weeks), and gave no evidences of constitutional disturbance.

These and other similar cases show that the presence of bacilli is not necessarily associated with fever although frequently it is so: and conversely, the cases recorded at p. 26 show that a suspicious pulmonary catarrh with some degree of fever does not indicate the presence of the bacilli. It has already been shown by WILLIAMS¹ that tubercle may form in more than one organ without giving rise to any marked increase of temperature, and in fact with a persistence of sub-normal records. This is more likely to be the case when albuminaria co-exists. In the early stages of bacillary phthisis, however, the temperature is generally raised, and even when it is apparently normal, if readings be taken for lengthened periods, slight occasional rises will be frequently noticed. The rate and character of the pulse is no safe guide in diagnosis: it may be rapid and soft, or slow and full, as some of the cases already indicated demonstrate.

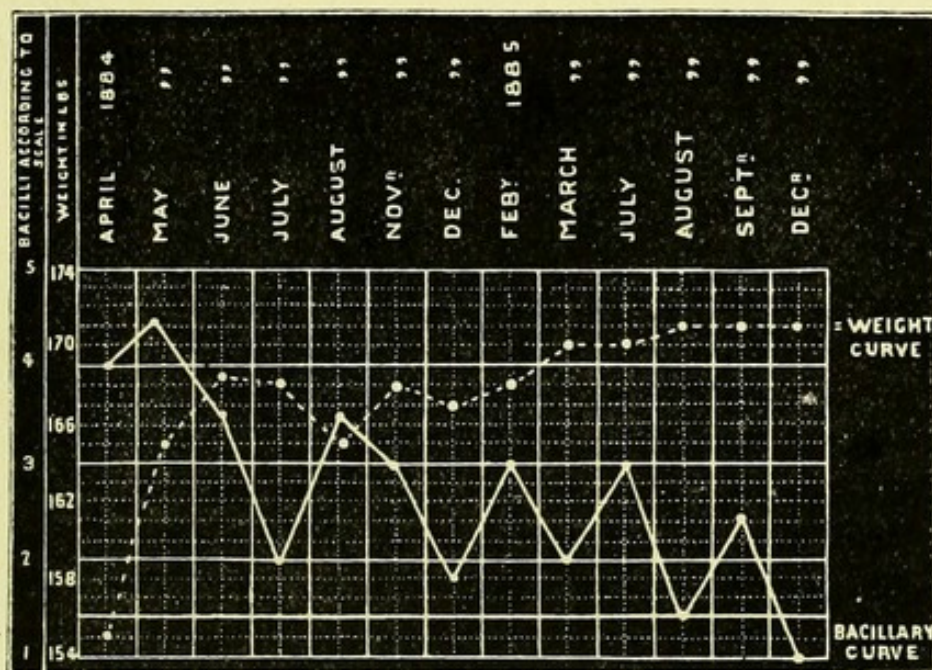
Amongst the important symptoms of early phthisis is loss of body-weight. This is presumably due to the concomitant fever, as also to the mal-assimilation of food which it induces. We may assume, therefore, that the loss of body-weight will be in direct proportion to the degree of fever, and when this is *nil*, as we have just seen may be the case in bacillary phthisis, there will be no loss of weight. As a matter of fact I have observed that the body may maintain, or even increase its weight, whilst the bacilli are not only present, but remain undiminished, or even increase, in numbers. An example of this is afforded by Fig. 16, showing the relation of the bacilli to the body-weight in the course of a case of rather chronic bacillary phthisis. In it the bacilli are seen to present a numerical zigzag curve, whilst the body-weight remains tolerably steady. Of this, I have noted other confirmatory examples.

The physical signs of early phthisis are frequently of so equivocal and undecided characters, varying from a completely negative to a feebly affirmative character that, even in the hands of accomplished diagnosticians, they but make the diagnosis

¹ Lancet, 1881, Vol. I., p. 971.

doubtful at the best. On the application of the bacillary test, however, vagueness and doubt give way to absolute certainty. It is not considered necessary here to adduce further cases in support of this proposition. Alike, therefore, in regard to the physical signs and general symptoms of early phthisis, the relationship of the tubercle bacillus may be shortly described by stating that it is present in the sputum at such a period as to render its recognition most invaluable in the detection of the disease, and further, that its presence affords the only satisfactory evidence of the existence of tubercular disease of the lungs. GERMAIN SÉE¹ affirms

FIG. 16.—CHART SHOWING THE RELATION OF THE BODY-WEIGHT TO THE NUMBER OF BACILLI IN THE SPUTUM IN A CASE OF CHRONIC PHTHISIS.²



NOTE.—The almost complete disappearance of the tubercle bacilli in December was accompanied by the development of enormous numbers of the micro-organisms as described on p. 10.

that this mode of "diagnosis (by the presence of the bacillus) is so precious that it precedes all other methods of investigation by months, and often years."

The prognostic value of the bacillary test in early phthisis has not the same accuracy as in diagnosis. In some instances the bacilli multiply quickly, are associated with

¹ Bacillary Phthisis, p. 165.

² In the Charts having reference to the numbers of the bacilli of tubercle, the scale devised and published by the author in the Edin. Med. Jour., 1884, p. 64, has been used. In it the figures 1 to 3 represent few, 4 to 6 abundant, and 7 to 9 very abundant bacilli.

rapid destruction of the lungs, or with marked general prostration, and soon induce a fatal issue. In other cases, they appear to have, at least for years, wonderfully little effect upon either the local changes or the general health. Thus, in the case of the young lady who has been under observation for nearly three years suffering from bacillary phthisis, and whose temperature readings are recorded at p. 33, the general condition is at present (December 1885) reported to be good, and the lung changes are but slight. In the case whose weight chart is given on p. 35, with bacilli varying from 100-200 in the field of the microscope, the patient asserts himself as never having felt in better health in all his life. He has well-marked dulness over the upper part of the right lung, which causes some shortness of breath on exertion; otherwise, he suffers little inconvenience from the presence of the germs. In such cases, however, where great improvement seems to take place without the disappearance of the bacilli from the expectoration, the patients are often subject to slight relapses, such as colds or hæmorrhages, and occasionally they suddenly break down in the course of apparent improvement. I therefore regard the presence and persistence of the bacilli as affording just cause for anxiety, and as indicating a general downward tendency on the part of the patient.

I have been unable to determine any direct relation between the numbers of the bacilli, and the gravity of the disease. In expressing this opinion, I make an exception in cases of very few or very many bacilli. These extremes do affect the prognosis, but the great class of moderates does so to a very small, if to any extent. One individual may, as already stated, live on in tolerable health with 100-200 bacilli in the field, whilst another may die in a comparatively short period, without the organisms having attained one-half that number.

The prognosis is rendered still more unreliable, not only by the numerical variations in apparently otherwise similar cases, but also by those which occur diurnally in the same case. Thus in a case of commencing phthisis, observations of the sputa were made on fourteen consecutive days, with the following results. The bacilli were, as a rule, extremely few in number, generally only from two to five being in the field.

On the fifth day, they could not be found in several preparations by two observers, and on the ninth day they were detected with difficulty. Sometimes they were found in the first cover glass, but occasionally several cover glasses required to be prepared to show them. In a case of tuberculosis supervening on chronic pneumonia, observations were also made on fourteen consecutive days. The number of bacilli usually ranged from about five to thirty, but on the sixth day fifty to seventy, and on the twelfth and thirteenth days one hundred and fifty were counted in some fields, and on the fourteenth about fifty. GAFFKY¹ has made an elaborate investigation into the diurnal variations of the numbers of bacilli in the case of fourteen patients for periods ranging from twenty to one hundred and thirty-four days. In ten cases, the bacilli could not be found on from one to five days only. In the remainder they were absent more frequently.

This variation in numbers, or occasionally complete absence, of the bacilli has been frequently noted in other instances, and consequently any attempts at prognosis founded on numbers alone, unless these are either extremely few or very many, are apt to be fallacious. Nor does it appear to me that, as some observers maintain, the method of arrangement of the bacilli in bundles or faggots has any decided prognostic value. The bacillary test is extremely valuable as giving an accurate indication of the existence of pulmonary tubercular disease, but it sheds little light on the course which this disease will pursue, unless in very extreme cases. My views on this point agree with those of GERMAIN SÉE, who says² "the multiplicity of the parasites does not in any way indicate the gravity of the lesion, nor allow us to foresee such accidents as hæmoptysis or pneumothorax."

Satisfactory evidence is afforded by Cases 15 and 16, that bacilli may be seen in the expectoration of early phthisis, in very small numbers indeed, and may afterwards disappear, with the apparent recovery of the individuals. The correctness of the observations in these cases is guaranteed by the same results having been arrived at by two independent observers. Both these cases appeared to originate in direct

¹ Mittheilungen aus dem kaiserlichen gesundheitsamt. II. Berliner, 1884.

² Bacillary Phthisis, p. 233.

infection. In the first case, by constant attendance upon a phthisical husband in whose expectoration tubercle bacilli abounded, and in the other case, by a brother who had lately died of acute bacillary phthisis. No active medication was adopted, but the cases will be more particularly referred to in the therapeutic chapters of the work.

3. The relation of the tubercle bacillus to advanced phthisis.—In the later and more recognisable stages of phthisis, the diagnostic value of the presence of tubercle bacilli in the sputum becomes diminished, whilst the physical signs and general symptoms of the disease become proportionately more pronounced. During the process of cavity-formation, bacilli are usually abundant in the sputum. When a cavity has formed, their numbers appear to depend upon whether it is a suppurating or a dry cavity, being usually moderately abundant and easily found in the expectoration of the former, but with difficulty, or not at all, in that of the latter. In fair abundance, therefore, they do not necessarily indicate a progressive tuberculation of the lungs, for their presence may be owing to a chronic cavity. In cases of rapid phthisis, without marked cavity-formation or fibroid changes, the latter stages are frequently characterised by the presence of enormous numbers of bacilli in the sputum. Such acute cases are illustrated by the following:—

CASE 20. Acute bacillary phthisis: enormous numbers of tubercle bacilli in the sputum: rapid death. Mr E., æt. forty-five, 17th January 1885.—Had enjoyed excellent health until six months previously, when he caught a severe cold whilst waiting in wet clothes at a railway station, followed by pleurisy and pneumonia. Breathing bronchial at both pulmonary apices: contraction of chest and impaired breath-sounds at left base posteriorly, with friction sounds at right base. Pulse 108, soft. Morning sputum frothy, muco-gelatinous, non-purulent. Enormous masses of bacilli are present at one particular part of first preparation, though in many fields of the same preparation not a single bacillus could be seen. In another preparation of the same sputum comparatively few bacilli could be seen. They were not found in the expired air of the patient, nor was elastic tissue detected. The patient died eleven days subsequently.

In this case the occurrence of enormous masses of bacilli, confined as they were to one part of the preparation might very readily have been overlooked. When found, however, they

justified a very unfavourable prognosis, which was warranted by the patient's early death. The mucous, non-purulent character of the expectoration is worthy of notice, and illustrates the truth of what has been already stated regarding the unfavourable character of this sputum when containing bacilli. This case further shows that the bacilli may be very unequally distributed throughout the sputum of very acute and grave cases, and may thus occasionally elude detection even by skilled and competent observers.

In the very acute cases—acute general tuberculosis—where the system rather than the lung is affected, the sputum may contain very few bacilli. In chronic phthisis, with undoubted cavity-formation, it may be impossible, as already remarked, to find bacilli in the sputum, as in the following case:—

CASE 21. Chronic pulmonary phthisis with cavities: no tubercle bacilli in sputum. A. B., æt. forty. — Admitted into the Longmore Hospital for Incurables, Edinburgh, suffering from the advanced stage of chronic phthisis. Has all the physical signs of large vomicae at both pulmonary apices. Sputum purulent: examined on twenty different occasions for tubercle bacilli, with negative results in each instance. On one or two occasions only were slight shreds of pulmonary elastic tissue present.

In cases of tolerably rapid cavity formation, the bacilli, fairly numerous during the process of softening, diminish when the formation of cavities has been completed. Such a case is seen on p. 32 (Fig. 15).

The relation of the tubercle bacillus to fibroid phthisis has not hitherto been agreed upon. The organism seems, as a rule, present in smaller numbers in this than in the other forms of phthisis, and is occasionally entirely absent. According to WILLIAMS,¹ this is not altogether because the bacilli are few, or non-existent in the lungs, but because the lung contractions block up the communications between the cavities and the bronchi, and the bacilli consequently cannot escape into the bronchi, and so be expectorated. On the other hand, Sir ANDREW CLARK² believes fibroid phthisis to be distinctly of a non-tubercular character, and to be owing to an extension of a primary dry pleuritic inflammation to the fibrous septa of the lung, and he has expressed his inability to find the bacillus of tubercle in the

¹ *Lancet*, 1883, Vol. II., p. 467.

² *British Medical Journal*, 1885, Vol. I., p. 685.

sputum in such cases. I agree with WILLIAMS, as I think I have observed several cases of fibroid phthisis, with bacillary sputum, of which the following is an example :—

CASE 22. Probable fibroid phthisis of lung: tubercle bacilli in sputum. Mr E., æt. thirty-five, 19th December 1884.—Phthisis pulmonalis of about three years' duration, commencing with an attack of pleurisy at the base of left lung. Pulse 80, dulness and sinking-in of left lung, especially at base, where there is almost complete absence of breath-sounds, with some coarse crackling râles on coughing. Respiration loud and rough at right base. Has violent paroxysmal attacks of coughing. Sputum muco-purulent, sanguineous. Bacilli present to the extent of eight to ten in the field, with shreds of alveolar elastic tissue. These results were confirmed on several subsequent examinations.

To the later stages of phthisis, the bacilli are thus seen to have no definite or uniform relationship. They may be absent, scanty, or abundant in the expectoration, but, be it observed, this does not by any means imply an equivalent bacillary condition of the lungs. In regard to prognosis, the utmost that can be said with any degree of accuracy is, that when present in excessive numbers, they portend a speedy fatal result. On the other hand, when scantily present, it does not follow that a given case of advanced disease may not terminate with rapidity.

As bearing upon the diagnostic value of the tubercle bacilli, and the inability to detect them in the sputum in certain cases of undoubted phthisis, the following interesting and instructive case is recorded by MÜLLER.¹ "A case of chronic pneumonia occurred, with wasting fever and consolidation of apices, in which bacilli were sought for in vain, until a few days before death, when they suddenly appeared in enormous quantities. The pneumonically infiltrated apices were found, after death, thickly studded with grey tubercles, a few of which had recently broken down and become confluent." Tubercle bacilli, therefore, may be abundantly present in the lungs, and appear late, or not at all, in the course of the case. The occurrence of either of these must, however, be regarded as a marked exception.

4. The relation of the tubercle bacillus to the other constituents of the phthisical sputum. This relationship, more especially that subsisting between the pulmonary elastic

¹ Verhandlung der physikalisch - medicinischen Gesellschaft zu Würzburg (London Medical Record, 1885, p. 84).

tissue and the bacilli, deserves some notice. Bacilli and tissue frequently co-exist in the same specimen of sputum, and together they indicate the breaking down of the lung from tuberculous causes. I have uniformly found that when the bacilli outweigh the tissue in numbers or amount, the prognosis is bad. The course of such cases is so rapid that death ensues before the lungs have had time to break down to any extent. The most unfavourable cases are those with a mucous, somewhat milky-looking sputum, with an abundance or a fair amount of bacilli, and mere traces of elastic tissue. Separately, tissue is more frequently met with in the sputum than are bacilli, being found in cases such as Cases 3 to 6, which are not, and do not become tubercular. On the other hand, tubercle bacilli are never found unless in active tubercular disease. Although, therefore, it is generally in phthisis that the elastic tissue is present in the sputum, the fact of its occasional occurrence in the sputa of non-tuberculous cases, such as chronic pneumonia and bronchiectasis, invalidates its claim to be considered as pathognomonic of phthisis. This applies equally to scanty, dubious-looking shreds, and well-marked leashes of tissue. I have only observed two cases of bacillary phthisis in which elastic tissue was not found in the sputum (Cases 16 and 20) synchronously with the appearance of the bacilli. In one of these cases the bacilli were very abundant, and a fatal termination rapidly ensued; in the other, very few bacilli were present, and recovery took place. I have not, so far, witnessed a case in which the presence of pulmonary epithelial cells heralded the appearance of tubercle bacilli in the sputum. Alveolar epithelial cells are frequently found in fair abundance in bacillary sputum, as also in that of non-bacillary cases.

SUMMARY OF OBSERVATIONS ON THE BACILLUS OF TUBERCLE.

Cases of Phthisical Disease	.	.	.	.	.	100
Cases of Non-phthisical Disease	.	.	.	.	.	76
				Total		176
Number of Observations	.	.	.	.	.	345
Number of Preparations	.	.	.	.	.	550

In the observation of phthisical cases, bacilli were found

In the 1st preparation on 195 occasions.

"	"	2nd	"	"	25	"
"	"	3rd	"	"	6	"
"	"	4th	"	"	4	"

Bacilli of tubercle could not be found in the following eight cases of consumption :—

1. Chronic case of phthisis with cavity-formation.
2. Case of miner's phthisis (anthracosis).
3. Case of laryngeal and pulmonary phthisis, with probably a small cavity at right pulmonary apex.
4. Case of very chronic phthisis.
5. Case of acute pulmonary phthisis with no expectoration.
6. Case of chronic phthisis.
7. Case of laryngeal and pulmonary phthisis in a pregnant woman.
8. Case of very chronic phthisis : sputum examined day preceding death, which was caused by an accession of catarrh from exposure to cold.

Of the eight cases of phthisis in which tubercle bacilli could not be found in the expectoration, it will be observed that four were examples of chronic phthisis in which, as has been already observed, bacilli may be few or absent. One was a case of coal miner's phthisis where the ulceration of the lungs was probably entirely due to the irritation of the inhaled carbonaceous particles. In Case 3, bacilli were detected neither in the laryngeal secretion nor the expectoration : this latter was probably due to the morning expectoration not having been obtained for examination. Case 7.—Here bacilli ought to have been found, unless it be the case, which is quite possible, that pregnancy retards their development and numerical increase. The absence of expectoration in Case 5, and the inability to detect any organisms in the expired air of the patient, explain why bacilli could not be found in it.

In the bacillary cases, elastic tissue was absent from the expectoration in one case.

It succeeded the bacilli after a very short interval in one case.

In all the other bacillary cases in which the double examination was made, bacilli and tissue were present. The presence of elastic tissue never preceded that of the bacillus, *i.e.* the tissue never had a prodromal relationship to the bacilli.

With the results now described—the presence of tubercle bacilli in the expectoration in 92 per cent. of all cases of phthisis—and their absence in every case of non-phthisical disease examined, it is obvious that their diagnostic value is of a very high standard. It may in fact be questioned whether any other disease possesses a single element or feature of equivalent diagnostic value. Certain it is that the bacillary test in phthisis far outweighs that dependent upon a combination of general symptoms and physical signs.

Even more striking results than the above have been arrived at by other

observers. Thus ZIEHL¹ out of seventy-three cases of phthisis found one only in which the bacillus of tubercle could not be detected in the sputum. In three hundred and eighty cases FRAENTZEL² found five only without tubercle bacilli in the sputum. GAFFKY'S observations on this subject have been already referred to (p. 37). The conclusions arrived at by other workers have been equally confirmatory in character.

It ought, however, to be borne in mind that the existence of tubercle bacilli in the lungs does not necessarily imply their presence in the sputum. Attention has already been directed to this fact (p. 40) as being likely to occur in certain forms of fibroid phthisis, and in other varieties of phthisis in which the access of bacilli to the bronchi, and consequently to the sputum, is obstructed. But the general rule is, for the sputum in tubercular disease of the respiratory organs or passages to contain the bacilli of tubercle.

¹ Deutsche medicinische Wochenschrift, 1883, p. 62.

² Ibid., p. 245.

CHAPTER VI.

THE SPUTUM IN PHTHISIS CALCULOSA, TRAUMATIC PHTHISIS, PNEUMO-MYCOSIS, AND IN ANTHRACOSIS.

IN certain forms of phthisis (*phthisis calculosa*) calculi are expectorated, and may be readily detected in the sputum.



FIG. 17.—CALCULI FROM THE SPUTUM (Natural Size).

These cases most commonly belong to the chronic variety, and, from their tendency to dry up, have a favourable prognosis. Rarely is the disease acute, as in the case from which the calculi were taken, which form the subject of the accompanying illustration. Dr M'ALDOWIE, of Stoke-upon-Trent, to whose kindness I owe the specimens, writes as follows regarding these cases of *phthisis calculosa*: "I had a case about a year ago where the patient brought one or two calculi every week which she expectorated. She is now quite well. There was no pain connected with their expectoration. It is curious that the exhibition of the calculi at the meeting (Local Branch of the British Medical Association) elicited the fact that the expectoration of these calculi is more common in this district than usual. Almost every practitioner has seen several such cases, whilst those from the middle and southern parts of the county have rarely, if ever, seen a case." According to RUEHLE,¹ the expectoration of these

¹ Ziemssen's *Cyclopædia*, Vol. V., p. 505.

cretaceous matters indicates a progressive softening, rather than a curative process. They may originate in the bronchial glands, and by ulceration may enter the bronchi, and thence be expectorated. He records the case of a child who was choked by the impaction in the larynx of a concretion as large as a cherry.

The composition of these calculi I have found to be mainly phosphate of lime, with a small amount of carbonates.

The expectoration of foreign bodies may follow immediately upon their entrance into the respiratory passages, or years may elapse before this occurs. The former is more likely to happen if the foreign body lodges in the larynx or trachea: if it passes into the bronchi it is more liable to impaction, and gives rise to a series of symptoms which closely simulate tubercular phthisis; there are, however, no tubercle bacilli in the sputa.

The presence of fungi in the sputa of various diseases (pneumo-mycosis) has already been alluded to; they are more especially met with during the later stages of phthisis with cavity-formation. OERTEL, who has specially investigated this subject, states that, in addition to various other forms of schizomycetes, there is one predominant variety generally present in phthisical cases. "In two cases of rapidly advancing florid phthisis with profuse expectoration, the expectorated matter was thickly beset with numerous fungi of this kind. The accumulation of fungi increased with the advance of the disease, and on the very last day the forms, still preserving the same type, were present in great masses."¹ In these cases the schizomycetes appeared as minute micrococci, arranged in rows of four or more, like a string of pearls. They never formed colonies, and were not associated with other putrefactive bacteria. The sputum resembled bronchorrhœic expectoration, but had no putrid odour. REMAK has found fungi (*aspergillus*) in the expectoration of pneumonia.

OERTEL does not consider these organisms to have any etiological importance. He thinks, however, that their effect is distinctly noxious, by the direct entrance of themselves or their products into the blood and tissues: they consequently afford a clear indication for treatment. I have seen organisms

¹ Ziemssen's Handbook of General Therapeutics, Vol. III. Respiratory Therapeutics, p. 360. By Prof. Oertel. Translated by J. Burney Yeo., M.D.

corresponding to OERTEL'S description in the sputum of certain non-tubercular pulmonary diseases. They are evidently non-specific in character.

Reference has already been made to a case (No. 16) in which the disappearance of tubercle bacilli from the sputum was accompanied or followed by the development of immense numbers of active sporiferous fungi in the expectoration. In this instance the fungus belonged to a variety which is frequently to be found in the expectoration and its presence seemed to cause neither local nor general disturbance. This replacement of a pathogenic by a non-pathogenic organism is curious and interesting. *Sarcinæ* are sometimes found in the expectoration. They were first described by VIRCHOW, and appear to have neither etiological nor diagnostic importance. They may be derived from the mouth, the throat, or the bronchi.

Blackening of the sputum from the presence of carbonaceous matter is seen in the case of those individuals, *e.g.* coal-miners, who are exposed to, and inhale coal dust (anthracosis). From the superior ventilation of the mines now in force, this discolouration of the sputum is not now so prevalent as in former years. The particles of carbon may be found lying free in the expectorated fluid, or enclosed in the cells of the pulmonary epithelium. I have found this variety of sputum present in the case of individuals who had for years ceased to breathe a carbonaceous atmosphere. Its detection is of little practical importance.

As with coal-miners, so with workmen who are exposed to other atmospheric impurities. These are all liable to inhale the dust and other impurities incidental to their respective occupations, which consequently may be found in the expectoration. Bacilli of tubercle are not, as a rule, present in the sputum of anthracosis: I have found them, however, abundantly present in a case of stone-mason's phthisis (Case 35).

The pulmonary affection most liable to follow the inhalation of dust is a mild variety of chronic bronchitis characterised by a mucous, non-purulent expectoration, in which the foreign particles may be detected lying free, or embedded in the cells of the epithelium. Bronchitic asthma is especially prevalent amongst the natives of the Highlands, who live in an atmosphere of peat smoke, and do not suffer from phthisis.

CHAPTER VII.

THE SPUTUM IN CERTAIN AFFECTIONS OF THE NOSE, MOUTH, AND PHARYNX, AND IN DISEASES OF THE LARYNX—TUBERCULOSIS, CANCER, SYPHILIS, CHRONIC INFLAMMATION, LUPUS.

IN addition to their value in the diagnosis of pulmonary diseases, sputa examinations are frequently of service in the recognition of diseases of the upper part of the respiratory tract.

The nasal fossæ and posterior nasal space are occasionally the sources of muco-purulent or purulent additions to the sputum. Thus, in post-nasal catarrh there is a collection of pus or muco-pus behind and above the soft palate, which is from time to time dislodged, partly spontaneously, and partly by the efforts of the individual. This condition is apt to be worst in the morning. I have known a collection of muco-pus in the posterior nares produce little trouble during the day, but during the night, with the patient in the recumbent position, it gravitated towards the larynx and induced suffocative spasms. In adhesive inflammation of the nares, with secretion of dryish pus, casts of various portions of the nasal passages may sometimes be detected, especially after attempts to irrigate or cleanse the nose. Spiculæ of bone are sometimes found in the secretion of chronic nasal catarrh.

The mouth and pharynx are the sources of certain constituents of the sputum. Besides the saliva, the mouth may be the source of a varied series of organisms which are, however, of no diagnostic importance. BEALE states that probably millions of germs are always present on the tongue and alimentary canal. Buccal epithelium is frequently met with, and ought to be recognised (Fig. 2). Thrush is characterised by the presence of a fungus in the mouth, and sometimes in the

sputum (*oidium albicans*). Blood in the sputum may be derived from the gums or teeth: in this case it is scanty, usually appears in the morning or during the night, when it may escape from the mouth and stain the pillow, and has a sweetish taste. Mycosis tonsillaris (FRÄNKEL) is caused by a *leptothrix* which forms whitish masses in the crypts and glandular openings of the tonsils, and may occasionally be found in the sputum. It is benign, and of no diagnostic import. As already stated, the acute specific diseases affecting the pharynx, such as diphtheria, measles, and scarlet fever, scarcely affect the sputum in such a way as to render this of diagnostic importance. Certainly, whatever their position as etiological factors may be, the organisms which OERTEL, KLEBS,¹ and others affirm to be invariably present in diphtheritic membrane, have no diagnostic value in the sputum. In diphtheria, shreds of membrane or ulcerated sloughs may occasionally be found in the expectoration: to these I am inclined to attribute more diagnostic import than to the presence of micrococci. In order to discover these shreds of false membrane, the expectoration should be examined in water. In putrid sore throat, gangrenous sloughs may also be found in the sputum. When these and other diseases of the deglutitory and respiratory tract affect children, specimens of sputa can seldom be obtained for examination, and diagnoses must therefore be made by other means.

The sputum may be altered or modified from artificial sources. Thus Dr W. A. DICKSON² describes the case of an individual with violet pigment discharged from the mouth, due to a piece of aniline pencil, which had caught in the false teeth. In cases of abnormal sputa, especially in regard to colour, the possibility of this occurrence ought not to be overlooked.

In diseases of the pharynx and larynx, the microscopic examination of the sputum is of the greatest value in diagnosing benign from malignant neoplasms, and malignant, tubercular, and syphilitic disease from each other. The laryngoscopic characters of simple, inflammatory, tubercular, cancerous, and syphilitic disease are at certain stages

¹ Allgem. Med. Centralbl. Zeitung, 13th October 1883. (London Med. Record, 15th January 1885.)

² Pathological Society of London, April 1885



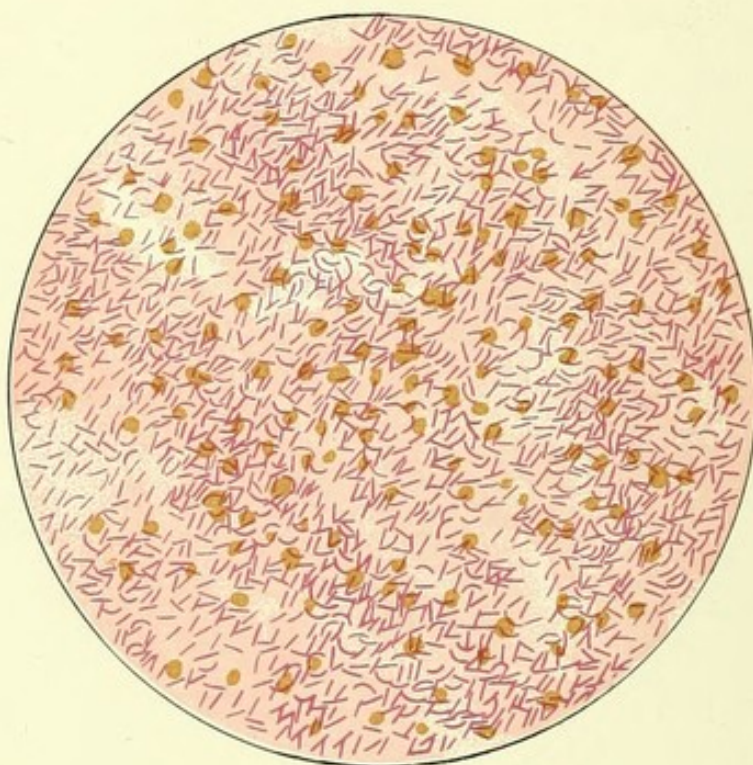


Fig. 18.—BACILLI OF TUBERCLE FROM THE SPUTUM IN A CASE OF LARYNGEAL PHTHISIS ($\times 350$, Ehrlich's Method : *Magenta and Chrysoidin*).

so similar, as often to deceive even experienced observers, and hence the great utility of the microscopic adjuncts. These views may be expressed with equal force regarding those diseases, in whichever part of the respiratory tract they may be situated; but as they most frequently affect the larynx, and as it has been chiefly in connection with this region that the following observations have been made, it has been deemed proper to discuss them in this place.

Tuberculosis of the larynx.—This may be primary, supervening on a simple chronic inflammation, or it may be distinctly secondary to pulmonary tuberculosis; the latter more frequently. In the former case, the examination of the sputum and the detection of the bacillus of tubercle can alone reveal the fact of the simple having merged into the specific. Tuberculosis of the larynx may be accompanied by a similar condition of the pharynx and mouth, as in a case I lately witnessed, in which the pharyngeal affection appeared as a superficial ulceration of the pillars of the fauces, and of the soft palate and uvula. In this instance an aggravated degree of ptyalism was present, as usually is the case in malignant and tertiary syphilitic disease of the same region. The sputum may be examined as it is expectorated by the patient, or the secretion coating the larynx may be removed by means of a brush, and examined microscopically. If the expectoration alone be examined, and bacilli found, these may have been derived from the lungs, but if they be found in the laryngeal secretion after the method just described, they indicate the tubercular form of laryngitis. Even when present in the sputum I have never been able to detect them in the laryngeal secretion, unless the larynx as well as the lungs were affected. In the sputum of laryngeal phthisis, especially if at all acute, bacilli are frequently present in enormous numbers (Fig. 18). In the laryngeal secretion, on the other hand, they are generally few in number, and may be detected only after two or three examinations. As in the case of pulmonary tuberculosis, therefore, these organisms are of value in differentiating the tubercular from other affections of the region. The coincidence of even a very few bacilli in the sputa from lung disease, and an apparently simple laryngitis, is of bad prognosis, for in such a case tubercular disease of the larynx will most likely ensue.

The sputum in laryngeal phthisis necessarily possesses many of the characteristics of that met with in the pulmonary variety of the disease, such as alveolar and epithelial cells, elastic tissue in varied arrangement, pus and blood corpuscles. The arrangement of laryngeal elastic tissue is seen in Fig. 20, taken from the expectoration of a case of simple chronic laryngitis in a strumous subject, from which recovery took place. The presence of laryngeal elastic tissue in the sputum is, therefore, of varied



FIG. 19.

import both in regard to diagnosis and prognosis. Blood is frequently present in streaks, seldom in excess. The extensive ulcerations and destructions of tissue which occasionally occur in laryngeal phthisis may cause necrosis and detachments of cartilage, especially the arytenoid cartilages, which may then be detected in the sputum (Fig. 19). This may also be the case with advanced malignant or syphilitic disease.

Malignant disease of the larynx.—The sputum in malignant disease of the larynx frequently, but not invariably, possesses certain well-marked characteristics, of a positive and negative character, which serve to differentiate it from similar affections.

The macroscopic appearances are not by any means pathognomonic. Pus is frequently, blood not so frequently present, and occasionally in the expectoration may be found pieces of tissue, white or fleshy in appearance, and varying in size from a pin-head to a bean. Occasionally these pieces of growths, becoming only partially detached, block the glottis, and interfere with respiration. I have known a patient labour from two to three hours before he succeeded in clearing away the obstructing mass by coughing: in another, suffocation seemed imminent. The presence of these nodules or pieces of growths invests the sputum with valuable diagnostic properties, and to their consideration I now direct attention.

In the case of epithelioma of the larynx or pharynx (squamous carcinoma), pieces of the neoplasm, sometimes as large as a pea, but generally smaller, are frequently found in the expectoration. These on being hardened and cut show typical cell-nests, as represented in Figs. 21 and 22, taken from the sputum in cases of epitheliomatous disease. The appearance presented



Fig. 20.—LARYNGEAL ELASTIC TISSUE FROM THE SPUTUM IN A CASE OF CHRONIC (Strumous?)
LARYNGITIS WITHOUT PULMONARY DISEASE ($\times 180$, Micro-photo-Lithograph).
Shows the elastic tissue embedded in the general *débris* of the expectoration.



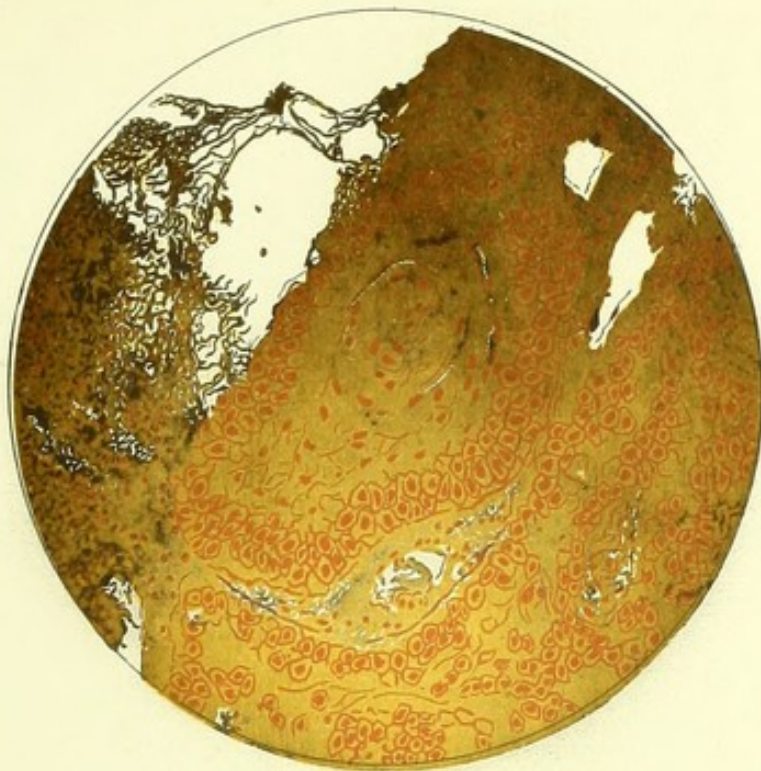


Fig. 21.—CELL-NEST FROM THE SPUTUM IN A CASE OF EPITHELIOMA OF THE LARYNX ($\times 350$,
*Picro-carmin*e, Micro-photo-Lithograph).



Fig. 22.—CELL-NEST FROM THE SPUTUM IN A CASE OF EPITHELIOMA OF THE LARYNX ($\times 350$,
*Picro-carmin*e, Micro-photo-Lithograph).



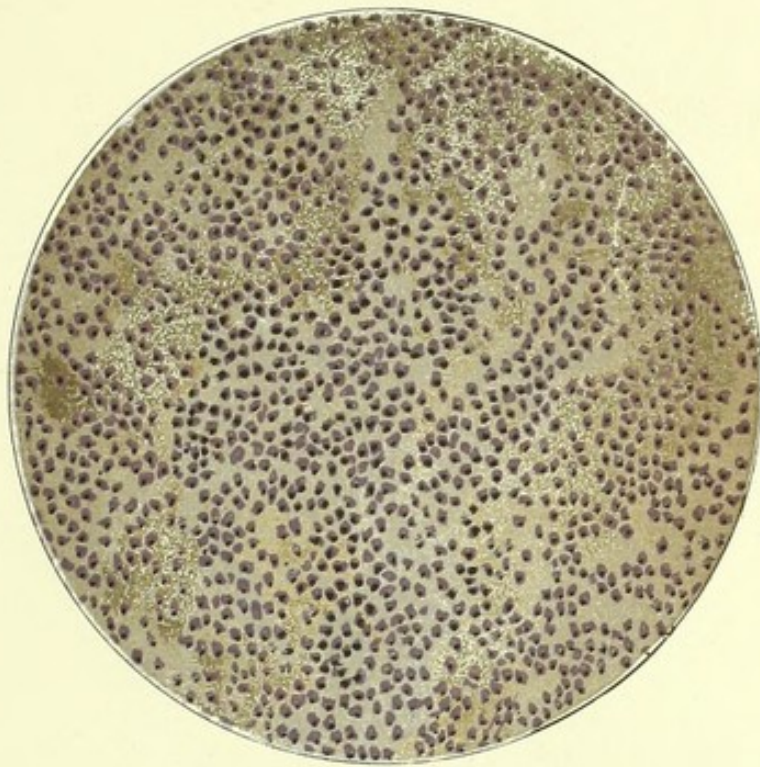


Fig. 23.—GRANULATION-TISSUE FROM THE SPUTUM IN A CASE OF CARCINOMATOUS DISEASE OF THE LARYNX, EARLY STAGE ($\times 350$, *Logwood*, Micro-photo-Lithograph).

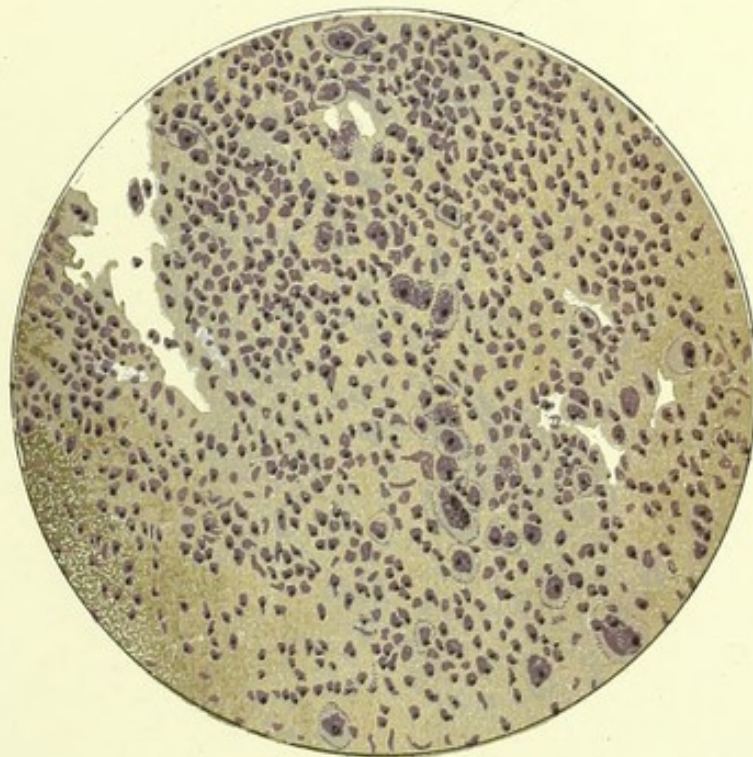


Fig. 24.—FROM THE SPUTUM IN A CASE OF CARCINOMATOUS DISEASE OF THE LARYNX, EARLY STAGE ($\times 350$, *Logwood*, Micro photo-Lithograph).
Epithelial cells are now seen scattered about the preparation.



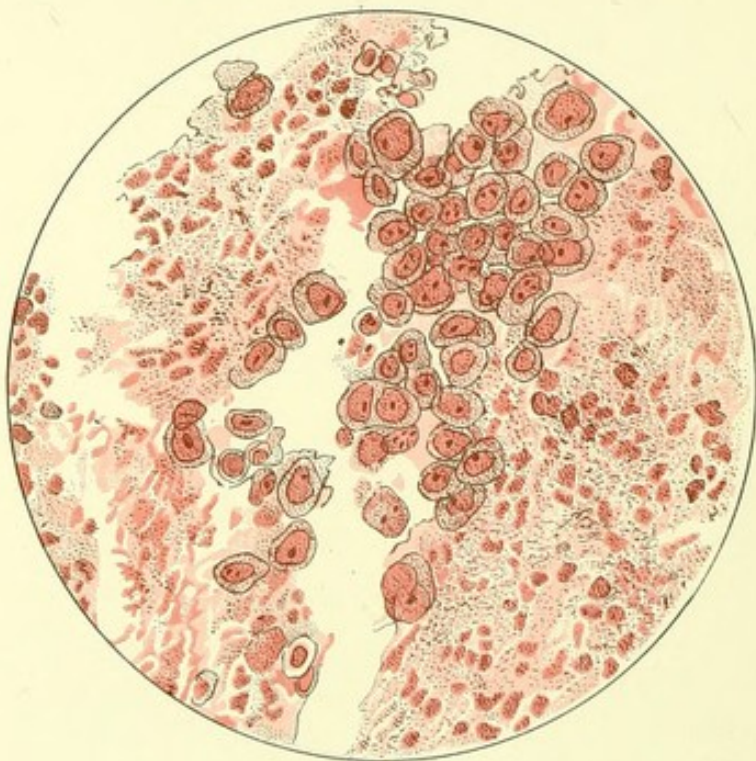


Fig. 26.—FROM THE SPUTUM IN A CASE OF CARCINOMATOUS DISEASE OF THE LARYNX,
ADVANCED STAGE ($\times 350$, *Picro-carmin*, Micro-photo-Lithograph).
The epithelial cells have now become more numerous and distinct.

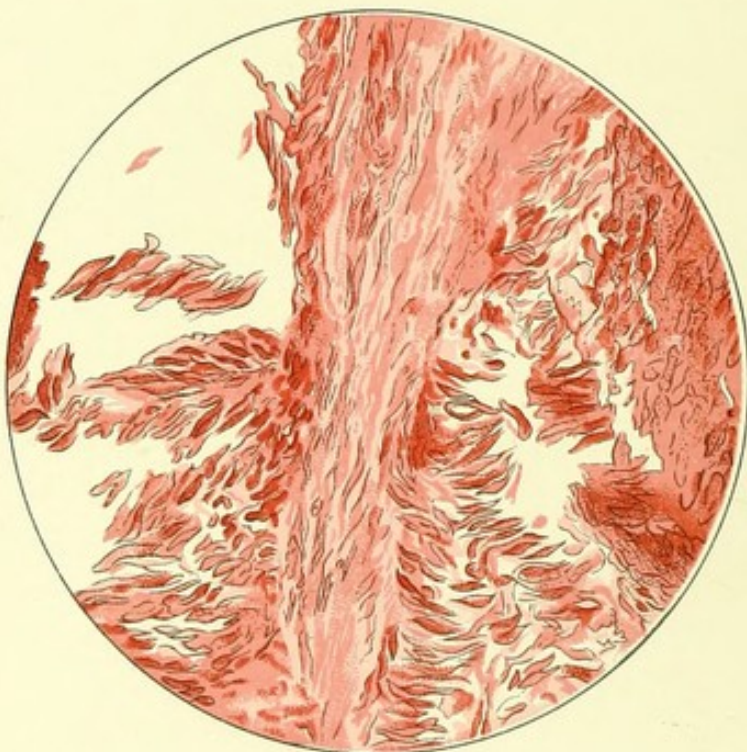


Fig. 27.—FROM THE SPUTUM IN A CASE OF PAPILLOMATOUS TUMOUR OF THE LARYNX
($\times 350$, *Picro-carmin*, Micro-photo-Lithograph).

by sections of these growths is not always so decided, as the following very instructive case shows :—

CASE 23. Laryngeal carcinoma, with granulation-tissue growths in the sputum. Mr X., æt. forty-five, 10th Nov. 1884.—He complained of hoarseness of several months' duration, the result of no apparent well-defined exciting cause. He never had any previous complaint. The whole lining of the larynx, including the vocal cords, was reddened, the left cord was almost totally immobile, and from its whole length a mucoid-looking fringe protruded into the glottis. At its arytenoid attachment was a nodular thickening. 1885, Jan. 9.—The fringe has now disappeared, the vocal cord and ventricular band present an irregular surface, nodular posteriorly, with superficial ulceration. Granulation-looking growths have from time to time appeared on this surface, and been expectorated (Fig. 25). On section and



FIG. 25.—GRANULATION-LOOKING GROWTHS FROM THE SPUTUM IN A CASE OF CARCINOMA OF THE LARYNX (Natural Size).

microscopic examination these simply presented the appearances of granulation tissue—a cellular infiltration with a granular matrix. In certain preparations a few large, epithelioid cells were sparsely scattered throughout (Fig. 24). 1885, Feb. 20.—Has expectorated four brownish fleshy-looking masses, varying from double the size of a pin-head to that of a grain of rice. The following is the report of their examination from the Pathological Laboratory of the University of Edinburgh :—

“Expectoration labelled Mr. X. Larynx case.—Membrane consists of fibrin similar to croupous exudation, and containing small round cells and blood corpuscles. Also at one part distinct epithelial growth of malignant character. Tumour may be regarded as epithelioma” (Fig. 26).

Tracheotomy, and subsequently thyrotomy, was performed by Professor CHIENE, and a soft friable tumour about the size of a small walnut was removed. It showed a distinctly carcinomatous character. The tumour recurred, and ultimately caused the death of the patient.

In this case, microscopic examination of the expectorated growths did not at first yield decided or characteristic results. They frequently presented the character of simple granulation or inflammatory tissue, and it was only in the later stages that the true nature of the affection declared itself by the sputa examinations. The clinical

resemblances between such a case and one of simple chronic laryngitis are very marked, and render careful and repeated examinations of the sputa all the more important as adjuncts to the use of the laryngoscope.

Malignant disease of the larynx may be coincident with tuberculosis of the lungs. I have observed one example in the case of a patient of the Western Dispensary. In this instance the laryngeal affection was supposed to be also tubercular until the expectoration and microscopical examination of a piece of the neoplasm revealed its epitheliomatous character. Dr DELAVAN of New York¹ reports a similar case (of malignant disease) in which "the condition differed little from an ordinary chronic laryngitis" (*vide* case of Mr X., *supra*)—"It commenced as a catarrhal laryngitis, was associated with pulmonary phthisis, and some time elapsed before appearances suggestive of serious trouble were developed." In such instances, the sputum would be modified according to the complexity of the cases.

These cases sufficiently illustrate the great value, not only of laryngoscopic, but also of microscopic examinations in all cases of laryngeal disease. In the case of malignant disease, the initial forms are so varied, and so closely mimic other disorders, that even the most dexterous and accomplished laryngologists may fail to arrive at a correct diagnosis. Microscopic examinations of the sputum, or of pieces of the neoplasm artificially detached if these do not appear spontaneously in the sputum, offer the only true grounds of diagnosis, the observer remembering the possibility of the presence of simple granulation tissue. In short, no diagnosis of laryngeal disease can be accepted as accurate where the microscopical examination of the sputum is neglected.

Benign growths of the larynx may also be detached, and be found in the sputum. Such an one is depicted in Fig. 27, which represents a section from a growth found in the sputum in the case of a papillomatous tumour of the larynx.

In the case of all such growths, and in order to their correct examination, it is highly necessary to have them hardened and cut, in the same way as in the preparation and examination of

¹ New York Medical Record, 2nd May 1885.

ordinary tumours elsewhere. Mere scrapings are apt to be misleading, especially in the case of spheroidal-celled carcinomas.¹

Syphilis of the larynx and pharynx.—Neither in the secondary nor tertiary forms of the disease have I been able to detect any specific organism (the so-called syphilo-coccus) in the sputum, the examination of which can therefore prove of value by its negative results only, and especially by its non-possession of the microscopical characters of tubercular or malignant disease. Carcinoma and tertiary syphilis may concur in the larynx, as in a case observed by me, in which a certain amount of benefit was derived from anti-syphilitic treatment. Latterly, however, the malignant elements became more pronounced, and death ensued. I have found pieces of cartilage and shreds of elastic tissue in the sputum in cases of tertiary ulceration of the epiglottis. Laryngeal syphilitic and tubercular disease may co-exist. According to RUEHLE,² “the larynx is the place, *par excellence*, in which syphilis and phthisis intermingle and intersect each other.” I have already recorded an example of the simultaneous occurrence of these two diseases.³ In cases of supposed laryngeal phthisis, therefore, it behoves the observer to bear this possibility in mind, and not to rest satisfied with a diagnosis founded solely upon the presence of tubercle bacilli in the expectoration and laryngeal secretion.

In other diseases of the larynx, *e.g.*, lupus, the sputum possesses no characteristic feature which can be utilised for diagnostic purposes. None the less, however, is its examination of service, for if by doing so the question of tubercle or cancer can be eliminated, an important aid towards the solution of any diagnostic difficulty will have been rendered.

Caseous glands may by ulceration obtain access to the respiratory passages. They may then be expectorated, or, becoming impacted in the tracheæ or larynx, may cause death by asphyxia.

¹ To Mr BUTLIN credit is due for having in his instructive work on “Malignant Disease of the Larynx” emphasized the necessity for this method of examining these growths.

² Ziemssen's Cyclopædia, Vol. IV., p. 545.

³ Phthisis of the Larynx: Edin. Med. Journal, 1883, p. 12.

CHAPTER VIII.

HÆMORRHAGIC SPUTUM.

ALTHOUGH only a symptom, the question of blood in the sputum, its probable causes, sources, and significance, is, especially when considered with certain coincident circumstances, of such importance as to justify its separate consideration, and to give it the "locum standi" of a distinct disease.

The sources of hæmorrhage in the sputum may be the nose, mouth, pharynx, larynx, and lungs. It is most frequently met with in the course of pulmonary or laryngeal tubercular disease, but is also frequently seen in simple inflammatory affections, in syphilis, and in malignant disease. In itself, therefore, it is destitute of any precise diagnostic value. The following represents my statistics :—

Number of cases of laryngeal or pulmonary disease with sanguineous sputum, seventy-five; of these, the number of tubercular cases was fifty-two. The causes in the other cases were pneumonia, bronchitic asthma, malignant disease of the larynx, rhinitis, varicosity of pharyngeal vessels, bronchitis, cardiac disease, syphilis, pleuro-pneumonia. In a few cases the causes were unknown. In 100 cases of phthisis, hæmorrhage characterised the sputum, at one period or other of the disease, in fifty-two instances. In twenty-six cases it appeared at an early period of the disease, in the other twenty-six its advent was a much later symptom.

The subject seems to divide itself into two classes, the tubercular and the non-tubercular.

I. The tubercular hæmorrhagic sputum.—The hæmorrhage in this variety may be present as mere streaks, or in such quantity that the sputum is composed of almost pure blood. After the formation of cavities, copious and sometimes fatal hæmorrhage may result from sudden rupture of vessels, which frequently present aneurismal dilatations from tubercular degeneration and

imperfect mechanical support of their walls. As may be surmised, this variety of sputum is distinguished from others by the presence of tubercle bacilli, not in the bloody, but in the purulent or muco-purulent portion, which usually appears on the subsidence of the hæmorrhage. An important question to consider is, the relation subsisting between the bacilli of tubercle and the effusion of blood. According to RUEHLE,¹ experiments on animals and clinical observations have shown that, when blood is effused into a healthy lung, the whole of it is readily absorbed, and no harm results. GERMAIN SÉE² believes that even in an already diseased (tubercular) lung the effused blood is ordinarily absorbed after a few days. It has also not yet been proved clinically that an attack of bleeding gives rise to tubercular disease, as indicated by the presence of tubercle bacilli in the sputum. HERTZ³ distinctly denies that bronchial hæmorrhage gives rise to pulmonary phthisis, and quotes SOMMERBRODT'S experiments upon animals, in which blood artificially thrown into the lungs entirely disappeared within five weeks, without leaving a trace of its presence. On the other hand, pulmonary hæmorrhage may result from tubercular disease possessing such obscure physical signs, that, were it not for the presence of bacilli in the expectoration, its presence could not have been recognised. An instructive example of this is recorded on p. 31, in which the hæmorrhage in the case of a lady with no definite physical signs of pulmonary disease was believed by a physician to be a "forerunner of tubercular disease," whereas the existence of tubercular disease had been diagnosed several months previously. It is needless to say that in this case the physician had not examined the sputum.

What bearing has the discovery of tubercle bacilli in sanguineous sputum upon prognosis, and in particular, with regard to the likelihood of recurrence of hæmorrhage? So far as I have been able to note, the bleeding, severe at first, may not recur, or if it do so, it may be in only small quantities.

CASE 24. Bacillary phthisis, with severe initial hæmorrhage: very slight recurrence. Mr A., æt. forty-five; severe hæmorrhage in Oct. 1883.—Tubercle bacilli in sputum. Nov. 1885.—The bleeding has not recurred, with the exception of a slight tinging of the sputum in Feb.

¹ Ziemssen's Cyclopædia, Vol. V., p. 92.

² Bacillary Phthisis, p. 92.

³ Ziemssen's Cyclopædia, Vol. V. p. 310.

1885. Tubercle bacilli still in the sputum, about the same number as formerly, and patient feels tolerably well.

CASE 25. Bacillary phthisis, with severe initial hæmorrhage: very slight recurrence. Miss B., æt. fifteen, June 1882.—Severe hæmorrhage: tubercle bacilli present in the expectoration. 1885, Nov.—The only recurrence of hæmorrhage took place about four months ago: in amount it was little more than a free admixture of blood with several successive sputa. The disease has made little progress, and the general health has been but slightly affected.

CASE 26. Bacillary phthisis, with free initial hæmorrhage: no recurrence. Miss P., æt. twenty-five, Feb. 1885.—Phthisis pulmonalis commencing with free hæmorrhage. 1885, Nov.—No recurrence of the bleeding has yet taken place.

These cases indicate what is not uncommon, that a case of bacillary phthisis may have severe hæmorrhage amongst its most prominent early symptoms, and yet may pursue its subsequent course with no—or only slight—recurrence. Nor does the occurrence of early hæmorrhage in bacillary phthisis necessarily aggravate the pulmonary condition, or expedite the course of the disease. The first two cases above narrated show that a free hæmorrhage may initiate a course of chronicity. A case of bacillary phthisis may be ushered in by hæmorrhage, and the patient recover (Case 16). The occurrence of hæmorrhage with or without the presence of tubercle bacilli may be an affair of trifling importance only, so far as the bleeding is concerned. On the other hand, very severe persistent hæmorrhage may co-exist with very few bacilli, and ultimately prove fatal. I have seen one such case in which tubercular disease supervened on an extensive chronic pneumonia.

In the later stages of bacillary phthisis, the presence of hæmorrhage in the sputum is of greater moment. It is then more exhausting to the patient, is more apt to recur, and is often followed by more local and constitutional disturbance than in the early stages.

Hæmorrhage from the larynx may occur in the course of tubercular disease, and must be diagnosed according to what has already been written on this subject. I have reported a case in which pulmonary hæmorrhage simulated pharyngeal, by a clot adhering to the retro-pharyngeal wall after expectoration, and appearing to originate therefrom.¹ It is in favour of the

¹ Edinburgh Medical Journal, October 1885.

non-laryngeal nature of hæmorrhage if the expectoration contain columnar and alveolar epithelial cells, more particularly if the latter be in abundance. In such a case, the bleeding is most likely to have had a pulmonary origin, and to be due to a catarrhal (congestive) affection of the bronchioles or alveoli of the lung.

2. The non-tubercular hæmorrhagic sputum. This is more rare than the preceding variety. It is usually much less in amount. It appears to be greatest in quantity when due to pulmonary congestion from valvular heart disease. No tubercle bacilli can be detected in it, or in the more mucopurulent secretion which succeeds it. It may contain elastic tissue in alveolar arrangement, as in Case 6, in which recurrent hæmorrhages, with elastic tissue and no tubercle bacilli, foreshadowed the development of a chronic pneumonia in a syphilitic subject. Alveolar and bronchial cells may also be present: these latter sometimes form casts or moulds of the terminal bronchioles, and indicate that the probable source of the hæmorrhage is in these. Hydatids of the lung may cause persistent hæmoptysis, and eventually prove fatal.¹ The diagnosis may be arrived at by the presence of daughter cysts in the expectoration, but these are occasionally absent. A considerable hæmorrhage during the course of a croupous pneumonia is considered to be of comparative unimportance.

The non-tubercular forms of laryngeal hæmorrhage are usually of cancerous or syphilitic origin: more seldom do they occur in simple laryngitis. The amount of blood expectorated in laryngeal hæmorrhage is usually small, but a case has been recorded in which about a teacupful was discharged. The examination of the sputum cannot be said to afford definite information as to whether it is of laryngeal or pulmonary origin. As already stated, it is in favour of its pulmonary origin if the blood, and more particularly so if the mucous or purulent secretion which accompanies or follows it, contains abundance of pulmonary alveolar cells. Laryngeal hæmorrhage may relieve any stenosis that may have been present before its occurrence, or it may give rise to this by the formation of a clot on the surfaces of the vocal cords, or by submucous infiltration.

¹ Case reported by Dr Percy Kidd, Pathological Society of London, March 1885.

Sanguineous expectoration, along with laryngoscopic examination, and an alteration of the character of the laryngeal respiration, will indicate the condition present.

In both tubercular and non-tubercular disease, the expectoration may consist entirely or mainly of blood, or blood may be present in the merest streaks. Excessive discharge of blood is usually indicative of tubercular disease. I have, however, lately noted a case of severe hæmorrhage without tubercle bacilli or elastic tissue in the sputum, but with evidences of apical affection of an inflammatory or catarrhal character, from which the patient completely recovered. The sputum in this case contained great numbers of alveolar epithelial cells, showing the existence of desquamative catarrh of the lung.

The colour of the hæmorrhagic sputum depends upon the amount of blood present in it, as also upon the length of time the blood has been effused before expectoration. It may thus vary from a bright crimson to a pale yellowish-green, corresponding, in fact, to the well-known changes which occur in subcutaneous sanguineous effusions. This greenish sputum from the presence of retained blood ought, if possible, not to be confounded with so-called biliary sputa: between these, however, it is extremely difficult to distinguish. The purulent sputum of phthisis has occasionally a greenish tinge without the presence of blood.

The diagnostic and prognostic relations of the hæmorrhagic sputum may be summarised as follows:—The presence of tubercle bacilli indicates the existence of tubercular disease of the lungs or larynx, or both. The occurrence of hæmorrhage in the early stage of bacillary phthisis is not necessarily of grave omen, for the bleeding may not recur, or the patient may entirely recover. A favourable result is more likely to ensue if the bacilli are few in number, do not cause much constitutional disturbance, and if the disease has been the result of direct infection, *i.e.* belongs more directly to the class of "Infective Phthisis" of R. E. THOMSON.¹ The most unfavourable features of early hæmorrhage in phthisis are recurrence, high fever, and abundance of bacilli in the sputum. Hæmorrhage has no relation whatever to the acute-

¹ Lancet, 1880, Vol. II., p. 726.

ness or chronicity of the disease. It may, in fact, frequently recur without adding to the gravity of the prognosis. The presence of elastic tissue with bacilli in the hæmorrhagic sputum does not alter the indications of the latter. Without tubercle bacilli it indicates a condition of simple chronic inflammation and ulceration of the larynx (Case 5) or lungs (Case 6). This variety appears most likely to occur in strumous or syphilitic individuals: the prognosis is favourable. Frequent recurrence may, however, take place. The presence of alveolar epithelial cells in abundance, usually with a sprinkling of columnar cells, without bacilli or tissue, shows the existence of a congestive catarrh affecting the pulmonary alveoli and bronchioles, from which the individual may completely recover. If neither bacilli, tissue, nor alveolar cells in abundance be present, the hæmorrhage, usually slight in amount, may be from the mouth or the posterior nares. This variety occurs most frequently in the morning. The bloody expectoration of croupous pneumonia and laryngeal neoplasms must be diagnosed according to what has been already written of these subjects. The hæmorrhage due to rupture of aneurisms or ulceration of large vessels can only be diagnosed, so far as the sputum is concerned, by its suddenness and excessive amount, along with its possession of certain negative characters indicating its non-tubercular or inflammatory nature.

The rapid discharge of blood from the lungs may induce vomiting, and the hæmorrhage may thus appear as if from the stomach. The former is distinguished by its initial cough, its bright colour, alkaline reaction, frothy appearance, by its tinging the sputum for some time, generally days, afterwards, and by its possessing the microscopical characters of the pulmonary or laryngeal disease with which it is associated. The latter is recognised by vomiting occurring first, by the acid reaction and dark colour of the blood, and by the appearance of sanguineous (tarry) stools for some days subsequently. Nocturnal epistaxis may simulate hæmorrhage of the throat or lungs.

The supplementary or vicarious hæmoptysis of women is of doubtful existence. GERMAIN SÉE¹ states "that it is found in women who, every month before, during, or after their periods, present pulmonary hæmorrhage often sufficiently

¹ Bacillary Phthisis, p. 89.

abundant, although rarely compromising life. If the coincidence is exact, and if in the intervals of the periods, that is, of the hæmorrhage, the general health remain intact without pulmonary trouble, there is every reason to believe in functional hæmoptysis. But in general we must distrust these derivations." He quotes ANDRAL thus (p. 92) "Nearly always when I have seen women spit blood at each menstrual period, I have assured myself they had tubercles. It is not always a capricious deviation of the uterine loss: far from it. The menstrual flux has been suppressed by pulmonary tuberculosis; the lung becomes a seat of a double congestion that is due to the tubercles acting on its vessels in a manner to compromise their integrity, and to a sort of plethora resulting from the retention of the menstrual blood." HERTZ¹ is of opinion "that whenever a bronchial hæmorrhage occurs before, during, or immediately after menstruation, or in the absence of the latter, it should be considered sufficient to call for a careful examination of the chest (and sputum?) for the lungs and bronchi of such persons are seldom normal."

My observations lead me to be extremely sceptical of the frequent existence of this vicarious or supplementary hæmorrhage. I have on several occasions witnessed the coincidence of the appearance of hæmoptysis, and the cessation of menstruation in early phthisis. If in such cases the physical signs of pulmonary disease be negative, with an absence of constitutional disturbance (Cases 15 and 18), and if the sputum be not examined for the bacillus of tubercle, a diagnosis might readily be arrived at of "vicarious menstruation." Incipient phthisis in women generally with, but occasionally without, initial hæmoptysis, is usually accompanied by a diminution or cessation of the menstrual flux. The occurrence of amenorrhœa, therefore, without a sufficiently apparent exciting cause, ought always to be viewed with suspicion, and should be followed by a rigorous examination of the chest, but more particularly of the expectoration.

¹ Ziemssen's Cyclopædia, Vol. V., p. 293.

CHAPTER IX.

THERAPEUTIC INDICATIONS OF THE SPUTUM IN LUNG DISEASE—PRO-PHYLACTIC AND REMEDIAL—THE INFLUENCE OF CLIMATE.

THE therapeutic indications afforded by the examination of the sputa in disorders of the respiratory system are frequently of great service to the physician, and, according to such indications, he may use varied remedies which are classified as emollients, solvents, astringents, styptics, disinfectants, sedatives, and parasitocides. These may be employed locally or generally, the former preferably.

The same methods of local medication may be applied in the case of diseases of the larynx and lungs, with the exception of powders, which, as administered by insufflation, hardly ever pass the larynx. The modes of medication applicable to both regions are those of inhalation and spraying, and according to the particular indications afforded by each case are either or both of these modes applicable. Inhalation may be practised by means of hot water inhalers, in which the medicament is volatilised by being added to a certain proportion of hot water, or by means of respirators, or respirator-inhalers, where the drug, necessarily more or less volatile, has its volatility increased by proximity to the body and the action of the expired air. Spraying is accomplished by one of two methods, in the cold state, by means of the usual hand spray, or in the warm state, by means of a steam spray, of which SIEGEL'S is the most efficient and least laborious to keep in action.

In the selection of one or other of these methods of local medication, the practitioner must depend largely for guidance upon the condition of the sputum, especially in regard to its consistence and amount, the difficulty or ease of expectoration, and the presence or absence of blood, germs, and putrefaction.

The principal of the emollient applications, having also solvent actions, are cold and heat. In acute or sub-acute catarrh of the respiratory mucous membrane in its earliest stages, with scanty muco-purulent expectoration, and in cases of croupous bronchitis, the use of a spray of cold or iced water is very pleasant to the patients, and facilitates the process of expectoration by diluting the somewhat dry secretion of the bronchial tubes. The administration of iodide of potassium or apomorphine, by increasing the secretion of the bronchial mucous membrane, and so facilitating expectoration, is likely to be of service in such cases. Apomorphine may be administered in doses varying from one-sixth to one-half grain. It is reported to make the mucus of the expectoration less tenacious, and the expectoration more easy. Administered hypodermically in doses of from one-thirteenth to one-sixth grain, it also acts as a speedy and safe emetic, and as such may be administered in certain forms of inflammation where suffocation appears imminent, the patient's strength being not too much exhausted. In the later stages, where the expectoration is more purulent and abundant, heat has a decidedly beneficial action, viz. hastening the suppurative process, and promoting the return to health. The soothing effects of heat or cold are frequently so marked as to render further medication uncalled for: in more chronic cases, however, it may be necessary to supplement their action by the use of solvents, of which the best and more effectual are the aqueous solutions of the alkaline carbonates. Solutions of common salt, sal-ammoniac, etc., may also be used for this purpose, but it has been proved by experiment that the solvent properties of these on mucin and its compounds are very much inferior to those of the carbonates. The use of these solvents is especially indicated in cases with a thick, viscid, mucilaginous sputum, which tenaciously clings to the walls of the air passages, and is expectorated with difficulty. Sprays of the alkaline mineral waters may also be used with advantage in such cases. In chronic cases, *e.g.* of bronchorrhœa, it may be advisable to attempt to diminish the secreting power of the bronchial mucous membrane by means of astringents. These ought not to be employed in the acute or sub-acute inflammations, as they are then apt to act as irritants, and so to aggravate the existent morbid

condition. In cases with a somewhat dry and tenacious expectoration, their use ought to be preceded by the employment of a solvent which allows the astringent to have better access to the respiratory mucous membrane. They may be applied by means of the handball spray (cold), which ought to be fitted with a tube and nozzle extending to, and pointing towards, the laryngeal aperture, or by means of a SIEGEL'S spray (hot). The astringents employed may be chloride of zinc, acetate of lead, perchloride of iron, or sulphate of alum, and they ought never to be used in stronger solution than $\frac{1}{2}$ to $2\frac{1}{2}$ per cent. These astringents may also act as feeble antiseptics and styptics. Excessive secretion may also be reduced by the use of inhalations of tar and creasote, and of the various balsams, such as cubebs, dissolved in spirits. These alter or diminish secretion, and change a somewhat copious purulent or muco-purulent sputum into a scanty purely mucous one. They are also of service where a disinfectant is necessary, as also are sprays and inhalations of oil of turpentine, carbolic acid, encalyptus, terebene, and the like. Disinfectant applications are strongly indicated in cases of fetid bronchitis, bronchiectasis, and pulmonary gangrene, and trial ought to be made of these various methods for correcting the fetor of the sputum, which is frequently very obstinate. Carbolic acid may also be administered internally in such cases in tablespoonful doses of a 1 per cent. solution. According to LEYDEN, alcohol, by internal administration, has also an antiseptic action on the pulmonary secretions. In irritable conditions of the air-passages, with frequent attempts at expectoration and scanty sputum, sedatives may be used as inhalants, such as conium, hyoscyamus, hydrocyanic acid, and chloroform. It is useless, however, to use these if the expectoration is in excess. These must be treated by the use of solvents and astringents, and sedatives ought to be used only when there is superadded a condition of bronchial or laryngeal irritability. GERHARDT¹ recommends respiration of condensed or rarefied air as a most powerful expectorant in cases of chronic bronchitis and bronchiectasis with copious and difficult expectoration. CURSCHMANN expresses the opinion that the presence of his spirals, in the sputum of asthma, indicates that the disease is not reflex in

¹ Deutsch. med. Wochenschrift, 1884, No. 43.

character, and consequently can only be cured by treatment directed towards the accompanying bronchiolitis. FRÄNKEL is of a contrary opinion, and states that these spirals may be found in reflex asthma, and that they afford no therapeutic indications.¹

The presence of blood in the sputum affords an important therapeutic indication, especially if in excess and associated with probable commencing or well-marked tubercular changes in the lungs. Styptics or hæmostatics may be administered generally or applied locally to the bleeding points. Of these two methods, the latter is undoubtedly preferable, especially in the recurring, though not excessive hæmorrhages, of chronic pneumonia, or commencing phthisis: they relieve the stomach from the necessity of absorbing quantities of drugs, the presence of which must undoubtedly impair digestion. The local effect of a hæmostatic, carefully applied, seems to be as satisfactory inside as outside the body, and more particularly is it thus in the case of the lungs. The most effective hæmostatic I have used is one first recommended to me by Dr SIDEY, of Edinburgh, and consists of a saturated solution of iron and alum in glycerine. I have used this preparation in various degrees of solution as a spray in several cases of tubercular and non-tubercular pulmonary hæmorrhage with benefit, not only in regard to the immediate effect upon the bleeding, but in reference also to the prevention of recurrence. It is of advantage to employ a form of spray by which the hæmostatic is removed from contact with the mouth and pharynx, and acts only on the respiratory passages. It cannot be doubted that, applied in this method, the particles of the hæmostatic solution are drawn not only into the lungs, but reach the ultimate air-cells in sufficient concentration to produce beneficial effect. Morphia, from its property of lowering the excitability of the bronchial mucous membrane, is a useful internal remedy in cases of hæmorrhage.

Sanguineous expectoration does not always indicate the employment of hæmostatics, as for instance, in cardiac valvular disease, where the bleeding is of service in relieving congestion, and the probably over-distended heart. Neither ought their use to be hastily resorted to in the sanguineous

¹ Berliner klinische Wochenschrift, 1873, No. 3.

sputum of tubercular disease, unless the quantity be great, or the period of bleeding prolonged. The concomitant pulmonary congestion is frequently lessened, and the patient's condition improved, by the moderate discharge of blood from the lungs.

Antiseptics and parasitocides now occupy a prominent place in the list of pulmonary therapeutic agents. Their use is indicated whenever decomposition has taken place in the lungs, rendering the sputum putrescent, as in putrid bronchitis, bronchiectasis, pulmonary abscess, and gangrene. The importance of the use of antiseptics in bronchiectasis and putrid bronchitis is evidenced by the opinion of THEODORE WILLIAMS, who states¹ that the commonest ending (of bronchiectasis) is death by septicæmia, from some of the fetid material being inhaled into the healthy lung, and inducing septic pneumonia, which soon proves fatal. In ordinary putrefaction, good results are obtained from the use of antiseptic sprays and inhalations, a few of which have been already enumerated. It is necessary here to observe that the occasional and intermittent use of these methods of acting upon the lung is useless: it is only by persistent and moderately continuous applications that a beneficial result can be attained. The various forms of schizomycetes which infest the tubercular lung, and doubtless exercise a baneful effect upon the individual independently of the disease, have been found by OERTEL to have their activity arrested, and be more readily expectorated, after the employment of sprays of carbolic acid (2-4 per cent.) or salicylic acid (0.2-0.3 per cent. solution).

The specific micro-organisms met with in the sputum have been seen to be two in number,—the pneumo-coccus and the tubercle bacillus. The doubts entertained regarding the identity of the former, and even if it be the cause of pneumonia, the tendency it has to disappear spontaneously from the expectoration, do not call for any observations upon its therapeutic indications. It is otherwise with the tubercle bacillus, for one of the most important therapeutic indications of the sputum in phthisis is afforded by the presence in it of this micro-organism, to which the disease is due. The radical, apart

¹ British Medical Journal, Feb. 26, 1881.

from the symptomatic, treatment, which latter is unquestionably too frequently the rule in phthisis, ought to aim either at the destruction of these organisms, or more correctly of their spores, or the prevention of their access to the system. As GERMAIN SÉE puts it,¹ "It is the bacillus, which, *à priori*, should decide the lot of the patient."

The question of the infectiveness of phthisis is one which claims some consideration. If we allow that the disease depends upon a specific micro-organism which has no independent existence (activity) outside its host, and that these micro-organisms do not originate "de novo," but from pre-existent germs of the same kind, we must be prepared to admit the infectiveness of phthisis, or in other words that tubercular disease can only originate from antecedent tubercular disease. That a certain disease belongs to the infective class does not necessarily imply that it has the power or property of attacking all who come within its area. We know that different diseases have varied grades of infective qualities, just as individuals have different degrees of susceptibility. The property of susceptibility or insusceptibility to a given disease, and the degree to which it is present in an individual, explain the amount of immunity which the individual enjoys. When, however, the degree of prevalence of tubercular disease of the respiratory organs amongst civilised communities is borne in mind, it cannot be affirmed that the infectiveness of the disease, or the individual susceptibility, is of a low standard. Some peculiar character of receptivity on the part of the individual, hereditary or acquired, appears necessary for the implanting and development of the germ, and the possession of this character by certain people and not by others, explains the absence of well-marked epidemic attacks of the disease.

The tenure of these views, supported as they are by high scientific authority, demonstrates that the treatment of tuberculosis ought to be prophylactic and remedial. As prophylactic measures may be mentioned the maintenance of the general health, the avoidance of the causes of local catarrh, and the non-association of those with a "tendency" to phthisis with the actual sufferers from the disease. The requisite standard of health

¹ Op. cit., p. 228.

is best maintained by breathing fresh air and avoiding damp. The great importance of keeping the feet dry ought to be carefully borne in mind. The immunity from consumption enjoyed by beggars, who frequently spend both their days and nights in the open air, has been remarked upon by several writers, and partly from this the inference has been drawn that "fresh air, more than good food, prevents the development of phthisis." Dampness, alike of the air and of the soil, is now widely recognised as a powerfully predisposing cause of consumption, and this fact ought not to be overlooked in the selection of localities and residences for threatened consumptives. BUCHANAN¹ has shown that the drainage of certain towns and districts of England has been followed by a reduction of the death-rate from phthisis. Individuals with a tendency to the disease, those, for example, whose constitutions are depraved from hereditary causes, such as from being descended from diseased, aged, or debauched parents, or those who, from exposure to cold or other causes, suffer from pulmonary catarrh, ought not to associate with consumptives. Every phthisical patient ought to be isolated, especially by night. Although the observations of WILLIAMS in regard to the presence of tubercle bacilli in the air of wards inhabited by consumptive patients have not been confirmed, nor those of RANSOME on the existence of bacilli in the breath of consumptives, it must be remembered that DE CHAUMONT has found pulmonary epithelium in the atmosphere, presumably from dried sputa. I am not inclined to believe, without further proof, that infection in phthisis is owing to the presence of bacilli in the expired air of tubercular individuals. As it has been proved that they abound in the tubercular sputum, and are not destroyed by drying at ordinary temperatures for prolonged periods, it is probable that in this way they, along with the pulmonary epithelium, eventually become mixed with other atmospheric impurities, are inhaled, and are either immediately thrown off, or settle down and develop, according to the degree of individual receptivity, and the amount of protection afforded to the lungs by its epithelial lining. The disinfection of the sputa of consumptives is thus of the greatest

¹ Ninth and Tenth Reports of the Medical Officer to the Privy Council, 1866-67.

importance in regard to the prophylaxis of the disease (See Chap. XII).

Another point requiring adjustment is in reference to the unity of the disease. My views of the treatment of phthisis are based upon the theory that there is one variety only, the so-called bacillary phthisis. The local (pulmonary) expressions may, and very often do, vary in their symptoms and course in individuals, and even at different times in the same individual, but the origin and essential cause are identical in all. Tubercular disease is one grand unity.

The prophylaxis of the disease consists, therefore, in locating those who possess a hereditary or acquired tendency to phthisis under such conditions as will afford them abundance of fresh air, dryness of climate and soil, and freedom from the risk of bacillary infection by separating them from those already phthisical, and by avoiding the use of the flesh or milk of tuberculous animals. The first is not difficult of attainment, and if attention be given to ventilation, abundance of fresh air is within the reach of most individuals. Climate we must take as it is, and in regard to the soil, how few in the selection of a residence give heed to the nature of the ground on which it stands! This may be, and frequently is, a cold damp clay, a circumstance likely to prove most disastrous to those with phthisical proclivities. The prevention of infection ought to be rigorously aimed at, by the thorough disinfection of the sputa of already tubercular cases, and by the segregation of the phthisical, or their separation from the phthisically disposed.

Remedial.—When the bacillus has obtained a footing in the lungs, as evidenced by its presence in the expectoration, its destruction may be attempted by means of climate, by the administration of general, or the application of local remedies, or by combinations of these. On account of the importance attached to this subject I propose to notice it in some detail.

I. The effect of climate upon the bacillus of tubercle.¹—In estimating the action of climate upon these

¹ The author has not on this occasion made any attempt at the classification of climate, the cases hitherto observed not having been sufficiently numerous to justify this. For the further consideration of this important question see JACCOUD on the "Curability and Treatment of Pulmonary Consumption," translated by MONTAGU LUBBOCK, M.D. No reference, however, is made in this work to the influence exercised by particular climates upon the bacilli of tubercle.

organisms, it is necessary to bear in mind their variableness in number without climatic or other treatment, as already pointed out in this work. Only by repeated examinations of the sputa, and by striking averages of the results obtained, can we arrive at conclusions with any degree of accuracy. The question which I have endeavoured to solve in each individual case is, has the change of climate had any effect upon the numbers of the bacilli, or upon the symptoms associated with their presence? The objection may be urged to this method of dealing with the question, that, in a given case, the numbers of bacilli may remain unaltered, but their virulency may be diminished. All proof, however, shows that bacilli within their hosts have equal virulent properties, and the mere presence of the organisms may consequently be accepted as evidence that the particular treatment employed has not destroyed the bacillus, nor deprived it of its virulent properties, and that tubercular disease is still in progress.

CASE 27. Residence at Tunbridge Wells, in the Riviera, and in Switzerland (Upper Engadine). Mrs R., æt. forty-five, formerly quite well, commenced to suffer from phthisis about the middle of 1884. The physical signs were almost *nil*, and the diagnosis of tubercular disease of the lungs depended mainly upon the presence of tubercle bacilli which were scantily found in the sputum. From mid-autumn 1884 to January 1885 was spent at Tunbridge Wells, from January to May 1885 in the Riviera. During the spring months two or three hæmorrhages had occurred. Sputum was forwarded for examination in May 1885; it was muco-purulent; the tubercle bacilli had greatly increased in number, there being now from 100 to 150 in the field of the microscope, with shreds of lung tissue. The report of the patient's condition at this time was, "she considers herself very well, has a good deal of strength, and is able for a good deal of walking." From May to October 1885 was spent in the Upper Engadine. On July 26th the patient was reported to be going on well: the tubercle bacilli remained as at last report.¹ On October 8, bacilli present in rather fewer numbers than on last two occasions, and the patient reports herself as feeling very well.

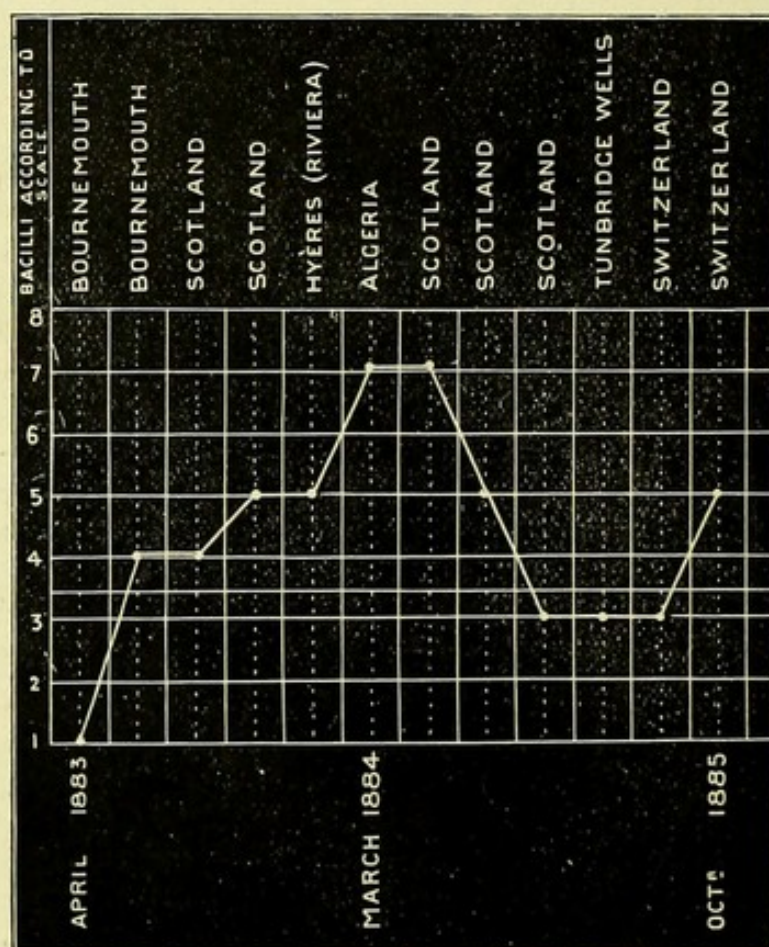
The most noticeable points in this case are, the great increase in the numbers of bacilli during the winter months at Tunbridge Wells, and in the Riviera, and their apparently stationary character whilst in the Upper Engadine. The small extension of the lung affection, and its slight effect upon the general health,

¹ Since this case was recorded, an opportunity has been afforded for a later examination of the sputum (1886, Jan. 12). The result has been to show a marked diminution in the number of the bacilli, which were scantily present in only one out of five preparations.

are also worthy of attention. The increase of the bacilli had, in short, extremely little effect upon the general health, and was not accompanied by a corresponding development of the local physical signs.

CASE 28. Residence at Bournemouth, in Scotland, the Riviera, Algeria, and in Switzerland (Upper Engadine). Miss R., æt. fifteen, had hæmorrhage in the summer of 1882, with dulness at the left apex, prolonged expiration, and dry mucous and cooing râles on inspiration. At the right apex were some sibilant sounds on inspiration. Temperature usually normal, occasionally rising to about 99° – 100° in the evening. Uses the oro-nasal respirator, and takes the hypophosphites. In September 1882 left for Bournemouth. The sputum was examined for the first time for tubercle bacilli on 15th April 1883. They were then found not generally throughout the preparation, but clustered in one particular spot. The bacillary course of this case, and the action of various climates upon it, as determined by sputa examinations, are represented by the following chart:—

FIG. 28.—CHART SHOWING THE EFFECTS OF DIFFERENT CLIMATES UPON THE NUMBERS OF TUBERCLE-BACILLI IN A CASE OF CHRONIC PHTHISIS.

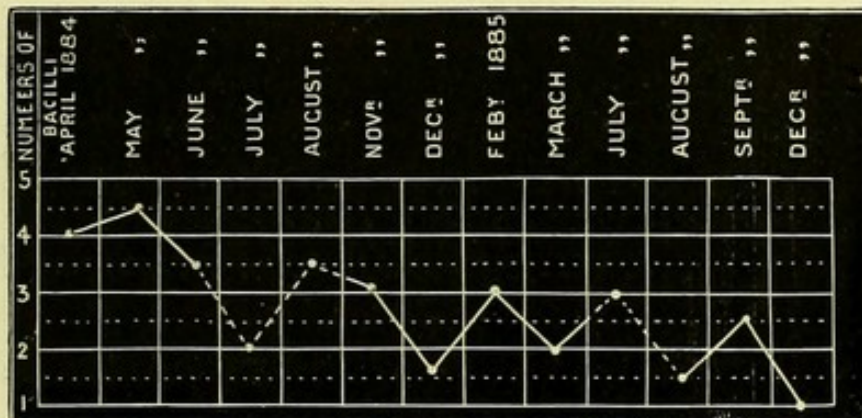


The course of this case was mainly non-febrile in character, with slow extension of the pulmonary lesions, occasional hæmor-

rhage to a small amount, and comparatively little change in the general appearance and body weight. It is interesting to note that tubercle bacilli were found most abundantly during the patient's residence in Algeria, where she spent a hot and wet season. Their numbers appeared to diminish after a return to Scotland, and residence in the bracing air of the Highlands. A summer in the Alps did not cause their diminution, and whether the Alpine winter climate will be more efficacious in this respect remains to be determined.

CASE 29. Residence on land (Scotland) and on the sea (chiefly). Mr H., æt. forty-five, March 1884.—Consolidation of whole of right lung, with pleural effusion at base. Formerly had some severe hæmorrhages. On 8th April 1884, about 100 bacilli were found in the field of the microscope. The bacillary history in this case is represented by the following chart:—

FIG. 29.—CHART SHOWING THE INFLUENCE OF RESIDENCE ON LAND AND ON THE SEA (PRINCIPALLY) ON THE NUMBERS OF TUBERCLE-BACILLI IN A CASE OF CHRONIC PHTHISIS.



NOTE.—The continuous line indicates the observations made whilst the patient was residing in Edinburgh. The interrupted line indicates those made whilst the patient was mainly engaged in yachting.

In this instance, it appeared to matter little, so far as the bacilli were concerned, whether the patient resided in a large city, or spent the greater part of his time on or near the sea. The occasion on which the bacilli seemed least numerous was towards the close of the second yachting season, although soon afterwards their numbers again increased. The important point for notice is, the apparently very slight effect produced on the numbers of the bacilli by what was very largely a sea life. Throughout the whole period of observation the presence of bacilli in the lungs had extremely little effect on the general

health, at least so far as the experience of the patient was concerned, and on no occasion was anything detected in the condition of the lungs to account for the discrepancy in the number of the bacilli.¹

CASE 30. Residence in Scotland: voyage to Australia. Miss P., æt. twenty-five. 1st March 1885.—Febrile hæmoptysis. Rough respiration at both pulmonary apices, with crackling sounds at left apex. Sputum mainly blood, with a slight admixture of mucus. Bacilli to the extent of about six in the field. 15th July 1885.—Patient's general condition better, but more bacilli in sputum, as many as fifty being readily detected in the field. Left for Australia, by steamer, viâ Cape of Good Hope. 27th October 1885.—A few days after landing in Australia, the patient despatched a specimen of her expectoration to Edinburgh. On examination to-day, it was found to be watery, turbid, and putrescent. Bacilli to the extent of fifty to sixty were readily detected in the field. They seemed shorter than before. The report received from the patient was, she had borne the voyage well, felt benefited by it, had very little cough, and had slightly increased in weight.

This is an example of the inefficacy of a sea voyage to drive the tubercle bacilli from the lungs, after they once have obtained a firm footing therein. The case appeared a suitable one for the production of a favourable effect, as the disease was at an early stage, and the patient was throughout able to follow the instructions given her to spend most of her time by day on deck. It is, of course, possible to imagine that, had not the voyage been undertaken, the organisms, instead of remaining almost stationary, might have undergone an increase in numbers.²

CASE 31. Residence in Scotland, first in the Lowlands, afterwards in an elevated Highland district. Mr H., æt. thirty. 1st April 1885.—History of pulmonary hæmorrhage. Slight dulness and coarse crackling at right apex anteriorly, and hoarseness. Sputum purulent, with a slight admixture of mucus: bacilli present to the extent of three to twelve in every field of the microscope. He was sent to reside on a hill in Perthshire, about 600 feet above the sea, with a dry sandy soil, and a north-westerly exposure. 27th August 1885.—The sputum has been examined at intervals of about a month since residing on the hill. The bacilli were, as a rule, easily found, to the number of about twenty in the field of the microscope, except on 28th June, when they were found with difficulty. The patient's general con-

¹ The concluding observation in this case (Dec. 1885) has been made since this paragraph was written. It shows almost complete disappearance of the bacilli of tubercle, and their replacement by enormous masses of the micro-organism described on p. 10.

² I have lately had the opportunity of examining the sputum of a patient of Dr Sidey, after a voyage to and from Australia, and residence in the colony for one year. The sputum was purulent, with three to twelve bacilli in the field, and also well-marked leashes of lung tissue. The double voyage and residence in the colony had failed to enable the patient to rid himself of the bacilli.

dition was latterly characterised by increasing weakness, emaciation and fever, and development of the laryngeal complications, and he appeared likely to live only for a few months longer. 14th December 1885.—Died.

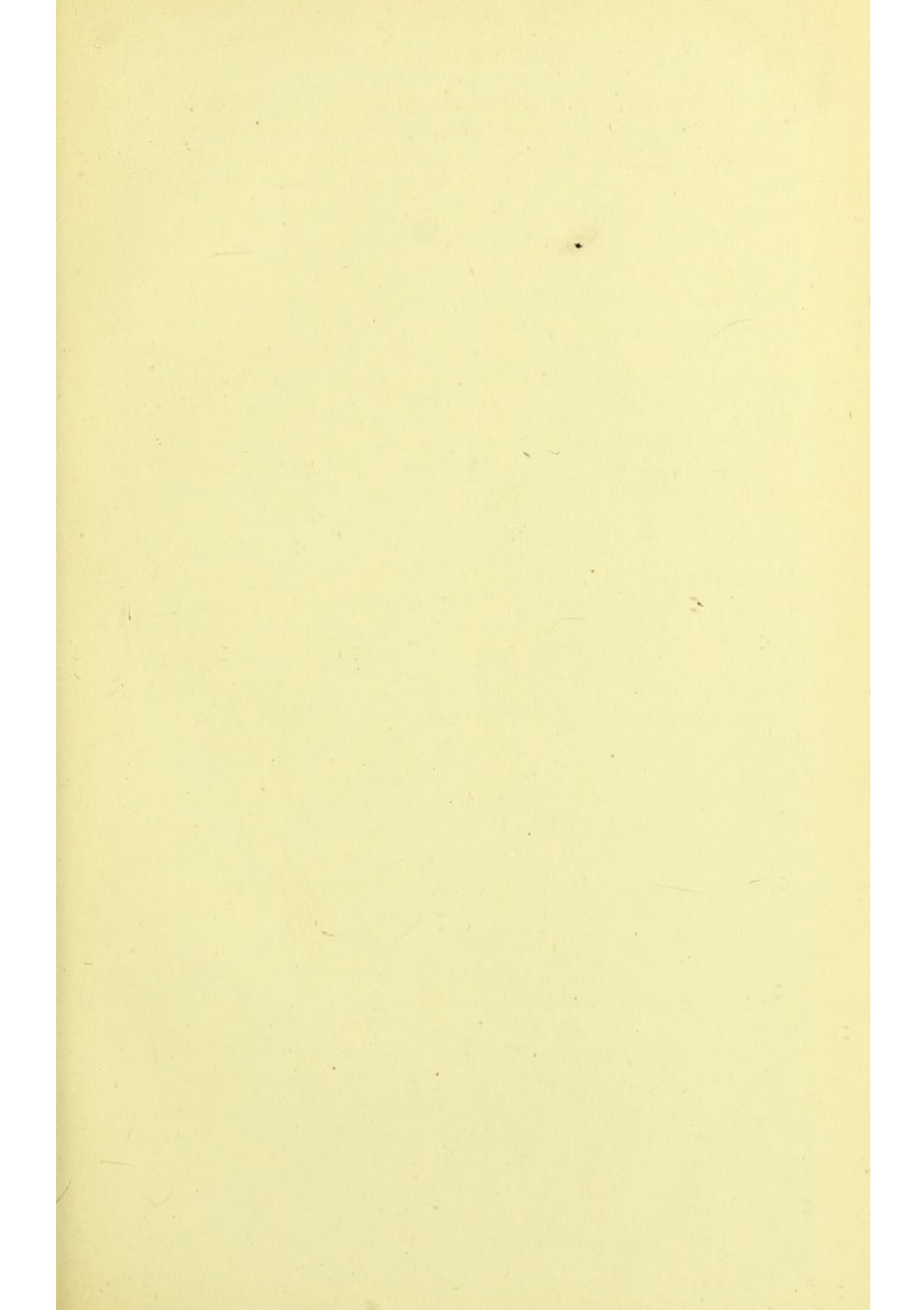
CASE 32. Residence in Scotland, at Bournemouth, and at Ventnor, Isle of Wight. Mr T., æt. twenty-two. 14th October 1885.—Pneumonia of right apex some months ago. Sputum one solid rolling lump, mainly purulent. Bacilli not present in first preparation; in second preparation two or three were occasionally seen in the field of the microscope. 1885, April.—After six months' residence at Bournemouth, the sputum was muco-purulent with about thirty bacilli in the field, and two months subsequently, mainly spent at Ventnor, about 100 bacilli were readily detected in the field. 26th July 1885.—Has returned to Scotland. Sputum muco-purulent with about fifty bacilli in the field. 14th October 1885.—Has been in the Highlands for the last two months, and has improved much in appearance and gained weight. Still some apical flatness and dulness. Sputum glutinous and very scanty, and only one or two bacilli found in two preparations. November 3.—Sputum very scanty; bacilli present, maximum number in field six, many fields without any. November 4.—Left for Australia.

In Cases 30 and 31, judging not only from the numbers of bacilli, but also from the local and general conditions of the patients, residence in the Highlands of Scotland appeared in the one not to improve the condition, whilst in the other marked improvement resulted. Case 31 was, however, characterised by the presence of laryngeal complications, which always tend towards rapidly fatal terminations.

In addition to the cases now instanced I have made similar observations in other examples of phthisis regarding the influence of climate upon the germs of the disease. In most of these instances the climatic changes have been of too short a period, or have, by the neglect of the patients to forward specimens of sputa for examination, been rendered insufficiently complete to warrant me in referring to them on this occasion, especially in view of the somewhat monotonous results attained in the cases now portrayed, with which they agree.

Referring to the cases now recorded, the results of the bacillary test, as in Cases 27 and 28, would certainly appear to show that the patients did not improve by residence in Algiers or the Riviera, nor at Bournemouth or Ventnor. It seems a matter for serious consideration whether patients with threatened or incipient phthisis ought to winter in these mild, warm, and relaxing climates, or whether greater benefits would not ensue upon

residence in cold, dry, and exhilarating regions, such as in the Alps. For incipient or threatening phthisis the best climate is probably one which is dry and with the minimum amount of changes of temperature, which ought to be rather low than high. The low temperature tends to dry up the pulmonary secretion, and diminish expectoration. It might thus assist in checking the growth of the bacillus, for in every case in which a diminution of the numbers of bacilli has been noted, the amount of expectoration has correspondingly decreased. Those climates, therefore, which "dry up" the expectoration are more likely to prove unsuitable for the growth and development of the bacilli. With advanced cases of phthisis it appears to be otherwise, for, unable to take much active exercise, they must necessarily reside in warmer climates if it is desired that they should spend a considerable portion of the day out of doors.



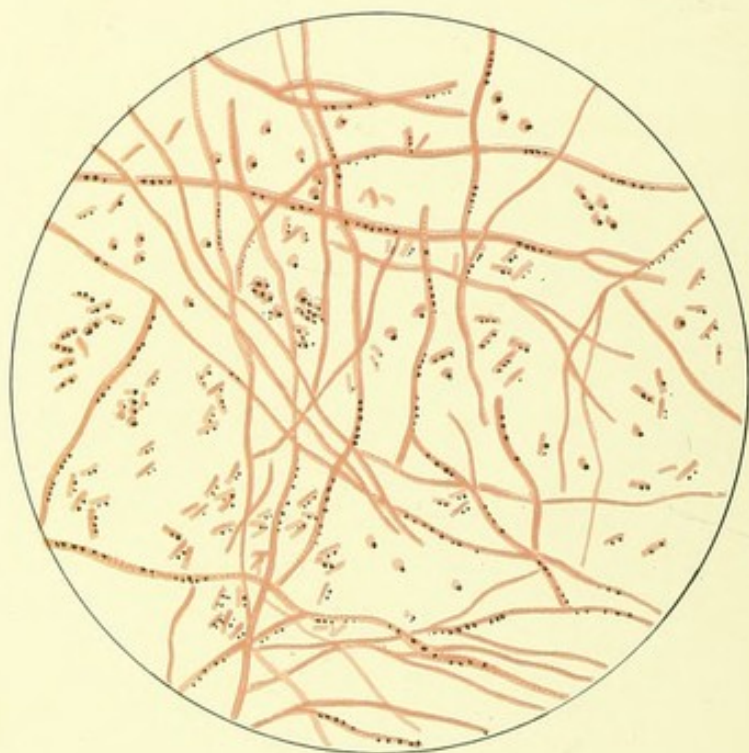


Fig. 30.—FUNGUS AND SPORES (LEPTOTHRIX) FROM THE SPUTUM IN A CASE OF PULMONARY PHTHISIS AFTER RECOVERY ($\times 300$, Ehrlich's Method).

CHAPTER X.

THERAPEUTIC INDICATIONS OF THE SPUTUM IN LUNG DISEASE (CONTINUED) —THE INFLUENCE OF LOCAL AND GENERAL REMEDIES.

I HAVE already recorded (p. 31) two cases of very early tubercular phthisis with bacilli in the expectoration, in which recovery and disappearance of the germs have taken place. As stated, no internal medication was practised in either instance. In the first case, the wife of a phthisical individual, separation from her husband by night was effected, and disinfection of all sputa, handkerchiefs, etc., was rigidly attended to. Both cases occurred at such a season as in Scotland permits of abundant outdoor exercise; to these and similar hygienic and dietetic measures, combined with the very early recognition of the presence of the organisms before they had obtained a firm footing, I attribute the recoveries. The immense number of active spore-bearing fungi in the expectoration of the second case on recovery is worthy of notice (Fig. 30).

2. The effects of local remedies upon the bacillus of tubercle.—The local remedies mostly in vogue for the treatment of tubercular disease of the lungs and larynx belong to the class of antiseptics. The system employed is inhalation, and this may be effected by general diffusion of the medicament in inhalation chambers or through the agencies of respirators and inhalers, or by sprays or powders. Each of these methods has its own advocates, but, whilst the general results of all of them have been frequently recorded, no detailed observations have as yet been made to indicate their effect upon the essential cause of the disease—the tubercle bacilli. Inhalations, diffused generally throughout the atmosphere, or applied locally, have been principally practised in tubercular disease of the lungs, whilst the use of sprays and powders has been generally resorted to when the larynx has been affected.

In the selection of an efficient antiseptic, it is requisite that this should possess both a positive and a negative quality—it ought to be destructive to the bacillus, and at the same time innocuous, or rather, beneficial and nourishing, to its host. Were it not for the latter essential quality, it would not be difficult to select a host of bacilli destroyers or sterilisers. But the combination of these qualities is extremely difficult of attainment, and hence the impunity with which these organisms, protected, sheltered, and nourished by their host, extend their ravages.

In the following series of cases I have attempted to indicate the action possessed by certain antiseptics and parasitocides upon the tubercle bacilli in man, as evidenced by their relations to the sputum. I have not had facilities for observing cases treated in properly constructed inhalation chambers, such as recommended and used by Dr HASSALL,¹ and therefore in regard to this my observations must be defective. I have no reason, however, to believe that any other results can be attained by this method, than by the use of medicated inhalers or respirators. Dr HASSALL affirms that, in aseptic respiration as carried out by any of the inhalers or respirators now in use, little, if any, of the antiseptic is inhaled, but remains on the material charged with it. He supports this view by certain experiments regarding the volatility of antiseptics at ordinary temperatures, oblivious that in a respirator-inhaler in use, the temperature of the inhalant is raised by the presence of the expired air and proximity to the skin. Three clinical facts, also, tend to controvert the view that the inhalant remains almost entirely on the substance with which it is charged, and is not drawn into the respiratory organs and passages :—first, the great irritation produced by various inhalants in laryngeal phthisis ; second, the beneficial effects upon the cough ; third, the alteration it effects upon the character of the sputum. Unless the antiseptic be inhaled, it is difficult to understand how it can irritate the larynx, abate cough, or modify the pulmonary secretions.

I venture, therefore, to believe that the results upon the tubercle bacilli of treatment by inhalation chambers will be found

¹ Inhalation Treatment, 1885.

to differ in no material respect from those produced by the tolerably continuous use of medicated respirator-inhalers, examples of which are now submitted.

Cases illustrative of the action of antiseptic inhalations upon the bacillus of tubercle.

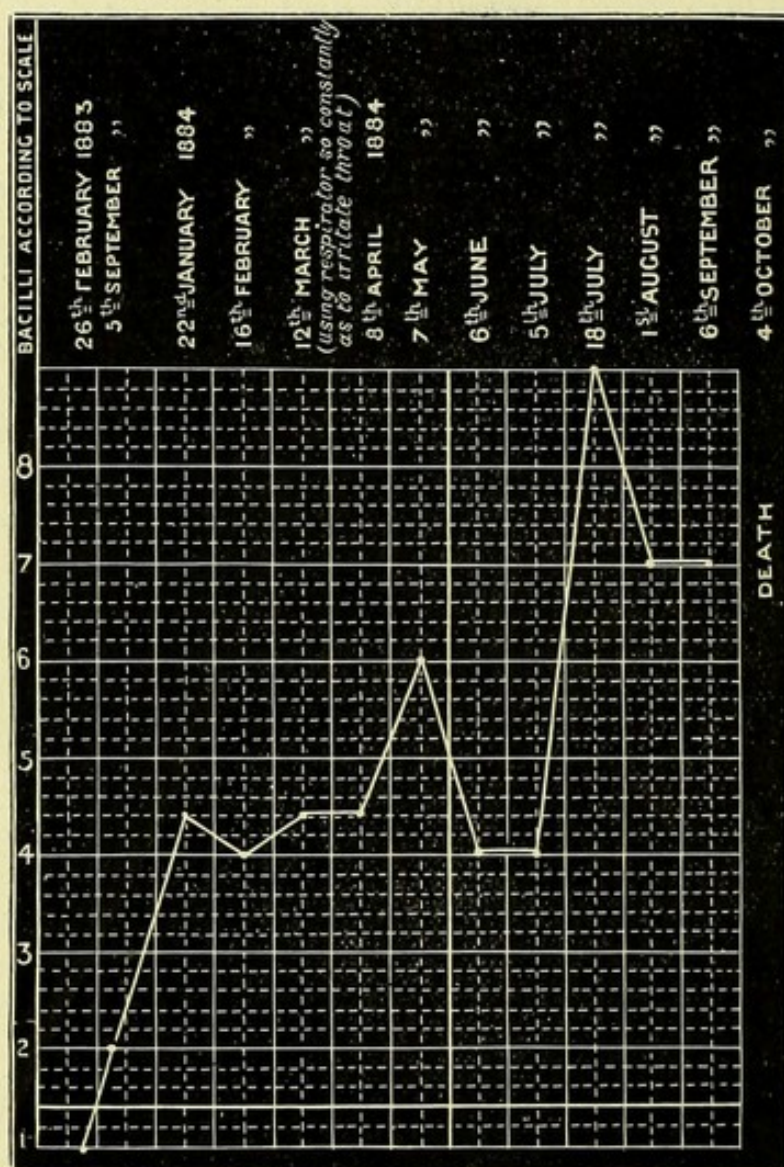
CASE 33. Early phthisis: no apparent effect of antiseptic inhalation upon the bacilli of tubercle. Mr C., æt. forty, 12th Feb. 1884. — Crepitation and slight dulness at both pulmonary apices. Sputum muco-purulent, lumpy, slightly hæmorrhagic. Bacilli present (2nd preparation) to the extent of about six in the field: several fields contained none. Treatment, local application of iodine to skin over pulmonary apices, and the continuous inhalation of carbolic acid and creasote by means of the oro-nasal respirator. 23rd Feb. — Has been using respirator for six to eight hours daily, and also during sleep. Sputum scanty, muco-purulent. Bacilli present, but found after careful examination only: in most fields they were absent: maximum number in a single field, six. Patient reports himself as feeling much better. 22nd March. — Continuing inhalation as before: sputum muco-purulent: bacilli present (2nd preparation), not in every field: maximum number in a single field, twelve: well-marked faggot-like bundle of six was seen. (The patient ceased to remain under observation at this period.)

CASE 34. Early phthisis: persistence of tubercle bacilli after treatment by antiseptic inhalation. Mr A., æt. twenty-two, 12th Nov. 1882. — Cough, hoarseness, and occasional night sweats. Fine crepitation on inspiration at both apices anteriorly: flattening and slight dulness at right apex posteriorly. Inflammatory reddening of vocal cords. The number of bacilli present in the sputum at this period was not noted. Treatment. — Use oro-nasal respirator with equal parts of creasote and carbolic acid. — 1883, June 11. — Since last report, patient has used the respirator in the most persistent and continuous manner, both by day and by night. As a substitute for the carbolic and creasote mixture, trial was made of an ethereal tincture of bromine, but the use of this caused such irritation, and gave so little relief, that it was discontinued. Great benefit was afforded to the cough by the use of the respirator. Sputum muco-purulent: bacilli fairly numerous and readily found.

In these cases, the bacilli were not eradicated from the lungs and sputa by very continuous use of antiseptic inhalations, in the first case extending over about six weeks, in the latter, about seven months. Although the numbers of bacilli present in Case 34 at the commencement of the inhalation treatment were not noted, the result showed that this treatment had neither eradicated them nor prevented their development. In the succeeding case, a very prolonged trial was made of antiseptic inhalations.

CASE 35. Phthisis pulmonalis: great increase of tubercle bacilli during treatment by antiseptic inhalation. Mr M., æt. thirty-two, 26th Feb. 1883. — Stone mason. Phthisis pulmonalis (stone mason's?) No perceptible dulness, but dry, crackling, and cooing râles down anterior portions of both lungs. Rigors and night sweats. Bacilli scantily present in sputum, only one or two found in each field. Treatment.—Continuous inhalation of creasote and carbolic acid. The bacillary course of the case is indicated on the following chart.

FIG. 31.—CHART SHOWING THE BACILLARY COURSE OF A CASE OF PHTHISIS UNDER TREATMENT BY ANTISEPTIC INHALATIONS.



The bacilli appeared in this case to increase with tolerable regularity notwithstanding the persistent and steady use of antiseptic inhalations, which, however, materially relieved the cough. The great and sudden accession of bacilli in the sputum of the 18th July was unaccompanied by any corresponding

extension of the physical signs, or aggravation of the general symptoms. No decided signs of cavity formation could be detected at any period of the disease.

CASE 36. Early phthisis: no apparent effect of antiseptic inhalation upon the bacilli of tubercle. Miss M., æt. thirteen, 10th April 1883.—Incipient phthisis of left apex. Sputum purulent. Bacilli present to the number of ten to fifteen in occasional fields. Uses oro-nasal respirator. The sputum was examined in May, June, and August with the uniform result that bacilli were always present: maximum number present in one field, thirty.

CASE 37. Phthisis pulmonalis: persistence of tubercle bacilli during treatment by antiseptic inhalation. Mr F., æt. fifty-four, 14th October 1884.—Phthisis pulmonalis of some months' duration. Patch of dulness about the size of half the palm of hand at sternal end of third right rib, with prolonged expiration over this area. Sputum greenish, mucopurulent, lumpy. Bacilli present to the extent of about a dozen in the field, notwithstanding the use of a Coghill's respirator with creasote and carbolic acid for the last two months.

In addition to these cases which have been recorded at some length, similar observations were made on other six phthisical patients who used antiseptic respirators for periods varying from one to five months, though not continuously. The result arrived at was the same in each—that this method of attempting to act upon the bacilli utterly failed to eradicate them, or apparently even to reduce their numbers. Altogether, whether regard is had to the numbers of the bacilli, or to the period over which the treatment extended, it cannot be maintained that even the persistent and continuous use of medicated oral or oro-nasal respirators has any effect upon the bacilli of tubercle. It does not prevent their increase, and most certainly does not accomplish their destruction.

My conclusions as to the ineffectiveness of this method of treatment so far as the germ of the disease is concerned and manifested in the sputum, do not prevent me from expressing my opinion that these medicated respirators are often of great service in the treatment of certain troublesome symptoms incidental to the disease. I have frequently witnessed their beneficial effects in soothing spasmodic cough, and favourably modifying secretion by diminishing its absolute amount and purulent proportion.

Similar results to the above were also obtained in cases in which the practice of antiseptic inhalations had not been the most prominent feature in the treatment, having been in them associated with the free internal administration of reputed remedies. It is evident, however, that if treatment by continuous inhalation as carried out in the recorded cases failed to benefit, it cannot be expected to succeed when intermittently or interruptedly pursued.

The prominence which has been given of late to the efficiency of the bichloride of mercury as an antiseptic agent has induced me to make trial of this remedy in phthisis pulmonalis. According to KOCH, this is the most powerful parasiticide, a solution of 1 in 300,000 being sufficient to arrest the growth of the bacillus anthracis. The following is a case thus treated.

CASE 38. Laryngeal and pulmonary phthisis: no effect of the bichloride of mercury spray upon the bacilli of tubercle. Mr R., æt. forty, 10th October 1885.—Pulmonary and commencing laryngeal phthisis. Slight crackling and dulness at both pulmonary apices. Sputum muco-purulent, with eight to ten bacilli in the field. For the laryngeal symptoms he was treated with suitable sprays and pigments. 30th Oct.—Commenced by means of a SIEGEL'S spray, the inhalation of a 1 in 2500 solution of the bichloride of mercury, four times daily, two minutes at a time. 23rd Oct.—Has gradually increased the duration of spraying to twenty minutes daily (four occasions of five minutes each), this being the maximum period of ability to submit to the action of the spray. Sputum muco-purulent: bacilli still present in slightly increased numbers. The spray has produced blackening of the tongue and teeth. 1885, Dec. 16.—Sputum muco-purulent, containing from twenty to forty bacilli in the field of the microscope. General health deteriorating. Has been using the bichloride spray three or four times daily since last report. As it has lately produced nausea and vomiting, its use has now been discontinued.

I hardly consider it necessary to adduce further evidence of the correctness of my conclusions, that no artificial inhalant, or system of inhalation, has yet been discovered which can be satisfactorily shown to have any appreciable effect upon the bacilli of tubercle.

Dr MORGAN'S observations¹ on the comparative immunity from consumption enjoyed by such of the west coast Highlanders as live largely in an atmosphere of peat-smoke, which

¹ British and Foreign Medico-Chirurgical Review, Oct. 1860. British Medical Journal, 23rd May 1885.

embraces in its composition several antiseptics, and the powerlessness of this remedy to effect a cure when the disease has obtained a start, seem to show that antiseptic inhalations, useless as curative means, may act beneficially as preventives of the disease. I would therefore recommend experimental trials of them in the pre-bacillary stage, when, in phthisically predisposed individuals, the sputum, in the manner already stated, shows catarrh of the smaller bronchi and alveoli, with or without the presence of shreds of elastic tissue. Such a sputum doubtless indicates a lung denuded of part of its epithelium, and the protection which that affords, and consequently favourable to the reception and development of the bacilli, an occurrence which might probably be prevented by the early adoption of precautionary measures of a medicinal or climatic character, and the removal of the patient from the neighbourhood of phthisical individuals.

3. The influence of general remedies upon the bacillus of tubercle.—To this class belong those medicaments which are meant to influence the bacillus through the system, presumably by so modifying or changing its constituents as to render it incapable of nourishing the germs. The various theories which, prior to the discovery of the bacillus, have been entertained in regard to the essential nature of phthisis, have called forth a host of supposed remedies suitable to these hypothetical conditions. These remedies are too numerous to mention, except the most prominent, such as cod-liver oil, lime, the hypophosphites, iodoform, quinine, arsenic, etc. JACCOUD¹ recommends the internal administration of creasote in 2-4 minim doses for prolonged periods, as diminishing the expectoration, and preventing extension of the catarrh. He says nothing, however, about its effect upon the organisms of the disease. After repeated trials of each of these, alone and in various combinations, I have failed to find that they influence in the slightest degree the presence of bacilli in the sputum. Cod-liver oil acts simply as a nutrient, and supplies the fat burnt up by the fever. The preparations of lime used by me have been the sulphide, the chloride, and the hypophosphite. The sulphide I have used in doses varying from $\frac{1}{8}$ th to 1 grain, three times daily, and

¹ The Curability of Pulmonary Phthisis, p. 159.

the chloride in ten-grain doses, as recommended by Dr SAWYER,¹ of Birmingham, but without in either instance influencing the organisms as found in the sputum. The hypophosphite of lime I have used as such, and in combination with other salts as the syrup of the hypophosphites, but also without effect. Following up the suggestion of EHRLICH (since, however, shown by ZIEHL to be incorrect), who asserted that alkalinity of the fuchsin stain was necessary to affect the bacillus, I have administered alkaline remedies internally, whilst the patient at the same time lived in an atmosphere of ammonia, but with negative results only. The affinity of the bacilli for certain aniline dyes, and the tenacity with which these are retained by them, even in the presence of an acid sufficient to drive the stain out of the other organisms and tissues, induced me to make the experiment of attempting to affect them in this manner in the tissues during life. I therefore administered fuchsin (rosanilin hydrochlorate) in pills to phthisical patients for prolonged periods, and in some with laryngeal phthisis added a spray of the same material, all without effect.

In view of the favourable opinions entertained by many of the profession regarding the utility of iodoform as an antiseptic, and the beneficial actions resulting from its local application and internal administration in laryngeal and pulmonary phthisis, I have been induced to make a somewhat extended trial of it. I consider the following case reported by me² fairly illustrative of its action.

CASE 39. Laryngeal and pulmonary tuberculosis originating in simple chronic laryngitis.—This case is thought worthy of record for the following reasons: 1. The priority in origin of the laryngeal as compared with the pulmonary affection. 2. The engrafting of a tubercular on an initial simple inflammation of the larynx. 3. The presence of the tubercle bacillus in the sputum and laryngeal secretion, and its aid in diagnosis and prognosis. 4. Certain toxic effects following the use of iodoform. The patient, a male aged fifty-five, was first seen by me on March 28, 1882. He complained of loss of voice, great pain in the ears, especially the left, inability to swallow properly, and cough. His throat affection had lasted for about seven years, and was supposed to have been due to a cold from sleeping under an open window. Hoarseness came on at that time, from which he had never been able to free himself, and which finally merged into aphonia. Family history was good. The man's previous

¹ British Medical Journal, 1880, Vol. I., p 845.

² Lancet, Vol. I., 1885, p. 187.

history was uneventful, with the exception of a slight cardiac affection of rheumatic origin some twenty years previously. He was tolerably healthy in appearance, of the rheumatic diathesis, with no indication of constitutional disturbance. On laryngoscopic examination, the arytenoid cartilages were swollen (not the typical pyriform swelling of phthisis), the ventricular bands and general mucous membrane of the larynx were irregularly thickened, and the vocal cords could not be seen. Some ashy-white secretion coated the central third of each ventricular band. Faucial sensitiveness was unexaggerated. The pulmonary symptoms were prolonged expiration, a slightly impaired percussion note, and a dry bronchitic click at the end of inspiration at the right apex anteriorly. The sputum was purulent, with a slight admixture of mucus, and contained the bacilli of tubercle in fair abundance in every field of the microscope. The patient was treated by local applications of chloride of zinc and subsequently of nitrate of silver to the larynx, with at first considerable benefit to the laryngeal appearances and symptoms and to his general condition, for from being confined to the house he was soon able to go out of doors. The main indications for treatment seemed to be to endeavour to subdue the local affection by metallic astringents, but a return of pain in the throat, and especially in the ear, compelled an attempt to alleviate the local conditions by sedative sprays, inhalations, and insufflations. Sprays and inhalations proving comparatively ineffectual, recourse was had to insufflations of morphia, at first alone, but subsequently combined with iodoform; these appeared to produce more benefit than any other local application. The course of the case tended gradually downwards. The laryngeal appearances and symptoms approximated more and more towards the tubercular, and signs of excavation at the right apex were detected towards the end of August. In January crepitant râles were abundantly present down the anterior surface of the right lung, with cavernous breathing at its apex. The pain in the throat and ear was occasionally very severe, especially on swallowing. The patient died on the 15th of February 1884, of exhaustion from inanition.

A post-mortem examination of the throat only was permitted. There was considerable destruction of the tissues within the larynx. The arytenoid cartilages had undergone necrosis and dislocation, the mucous membrane in their vicinity was swollen and infiltrated, and the ventricular bands had disappeared from ulceration. The vocal cords were intact, except at their arytenoid attachments, where a loss of substance to the extent of one-sixth had taken place. The general mucous lining of the larynx was irregularly thickened, and at the posterior parts of the ventricles on both sides were deep excavating ulcers, leading to the necrosed arytenoid cartilages. Bacilli of tubercle were found in the following situations: (1) In a scraping of mucus from the lower part of thyroid and upper part of cricoid cartilages. Here they were few, with an aggregation of about twenty in one field. There was no subjacent ulceration. (2) Underneath the anterior commissure of the vocal cords they were about as numerous as in the first situation. (3) In the secretion filling the laryngeal ulcers leading to the necrosed arytenoid

cartilages they were from three to four times more abundant than in the other situations. Microscopical examination of sections from the region of the ventricular bands failed to show the presence of tubercle bacilli in the tissues.

As stated in the introduction, the features in the case worthy of notice are as follows :—

1. The priority in origin of the laryngeal over the pulmonary affection. — The history of the case undoubtedly points towards the larynx as being the part first affected. The commencement of a sore-throat, with hoarseness, could be traced to one particular evening when the patient, having placed himself in a draught, caught cold. He had hitherto enjoyed good health, and had no predisposition to tubercular disease. He was also assured by a medical practitioner whom he consulted about two years subsequently, in consequence of the persistent hoarseness, that his lungs were quite normal. The whole history and evidence pointed towards laryngitis, of a slow insidious form, as the starting-point of the disease. The examination on my first visit to the patient showed the laryngeal to be much more severe, and apparently of longer duration, than the pulmonary affection. A simple chronic inflammation of the larynx was undoubtedly the first link in the chain which led to such disastrous results to the patient.

2. The engrafting of a tubercular on an initial simple inflammation of the larynx.—It may reasonably be inferred that, not only at the commencement of the disease, but for some years subsequently, the condition present was one of simple inflammation of the larynx. Tuberculosis of the larynx lasting for seven years, without being accompanied by extensive pulmonary changes, is, it is believed, quite unknown. In the present case a persistent chronic inflammation of the larynx disorganised and weakened the organ, and rendered it a suitable nidus for the reception and development of the tubercle bacilli, which readily reached it by inhalation. A progressive chronic inflammation appears to subserve this purpose more effectually than an acute inflammation, even where the latter leaves unmistakable traces of its presence in the form of permanent laryngeal changes. A case has been under constant observation during the last four years in which an acute laryngitis, at one time threatening suffocation, has played considerable havoc with the structures and integrity of the larynx, but without evincing any tendency towards tuberculisation. On the other hand, several cases, mostly in men, have been noted where, as in the present instance, a slow, gradually progressive inflammation of the larynx has undoubtedly ushered in tubercular disease both of the larynx and lungs. It is impossible to state with precision when the simple inflammation merges into the tubercular unless careful microscopical examination of the sputa be made from time to time with a view to the detection of the bacillus of tubercle. This is undoubtedly the variety of laryngeal tuberculosis in which the laryngeal precedes and leads to the pulmonary deposit, and may therefore justly be called primary laryngeal tuberculosis.

3. The presence of the tubercle bacillus in the sputum and

laryngeal secretion, and its value as an aid in diagnosis and prognosis.—Of the laryngoscopic appearances in the case the utmost that could be stated was that they indicated a severe form of chronic laryngitis. The chest symptoms showed a bronchitic condition, with probably slight consolidation at right apex. The temperature chart afforded small indication, for the average of fifty observations was, morning 98·2°, evening 98·6°. The discovery of the bacillus in the sputum supplemented in a most material way the other signs and symptoms, and afforded undeniable evidence that the case was of a more unfavourable character than was at first apparent. From March 28, 1883, till the date of death (Feb. 15, 1884), the sputum was examined on seventeen occasions, at about regular intervals, for the bacillus of tubercle, with the following results. On each occasion but one they were readily detected. In fair abundance in every field at first, their numbers afterwards seemed slightly to diminish, and in several fields they were not detected. They again slightly increased, and on Aug. 12 a very few were found in the laryngeal secretion on its removal by a brush. On Sept. 22, on testing the mucous and purulent portions of the same sputum, they were found from two to three times less abundant in the mucous than in the purulent portion. On Dec. 15, after a hæmorrhage to the extent of one or two mouthfuls, with marked signs of disease at both pulmonary apices, especially the right, and infiltration of the base of the right lung, they were present to the number of from fifteen to twenty in the field, rather isolated, but occasionally two lay in contact in a v-shaped arrangement, or three or four together, but not in contact. On January 16, after steady persistent treatment by iodoform insufflations and inunctions to the extent of inducing iodoform intoxication, the sputum, muco-purulent in character, contained as many as from forty to fifty in the field, generally not in contact. On Jan. 19, under a continuance of the iodoform treatment, they could not be detected in the sputum, this being the only occasion when such was the case but when the examination was repeated five days afterwards they were readily detected. It was probable, therefore, that some error in the preparation of the sputum interfered with their detection on the 19th. On Feb. 4 they were again found in the laryngeal secretion to the extent of fifteen in one field. The bacillary history of the case may therefore be shortly summarised by stating that these organisms assisted materially in the diagnosis, that they steadily persisted in the sputum, despite constant treatment by metallic astringents, antiseptic sprays, and iodoform insufflations to the larynx, and that their presence was not accompanied by febrile or other constitutional disturbance. Treatment by iodoform was pushed as far as was considered judicious, but without effecting any reduction in the number of the bacilli, although it diminished the putrefactive odour of the sputum. It is worthy of particular notice that on post-mortem examination, not only were they found in the secretion of the laryngeal ulcerations, but also in the mucus coating the crico-thyroid area, without subjacent ulceration. In the region of the ventricular bands and in the ventricles of the larynx, where they were from three to four times more abundant than in

the crico-thyroid region, their presence was associated with deep destructive ulceration. This diversity may have been partly owing to the ventricles of the larynx affording a more secure nidus to these organisms, but probably partly also to the fact that the inferior regions of the larynx and the trachea are lined by a mucous membrane which is closely applied to the inner surfaces of the tube, and whose deeper layers (submucosa) contain strong bands of elastic longitudinal fibres. Whilst, in my experience, it is not uncommon to find erosion of the epithelium in the trachea and lower division of the larynx in phthisis, one can never detect the same destruction as in the neighbourhood of the ventricular bands and arytenoid cartilages. The cartilaginous framework of the larynx and trachea has a resistant power which the softer tissues do not possess, and though, as would appear from the present case, the bacilli of tubercle cling to the whole of the respiratory tube, it is only in the softer tissues of the larynx and in the delicate alveoli of the lungs that their presence leads to deep destruction of tissue.

4. Certain toxic effects following the use of iodoform.—This drug was applied by insufflation and by inunction over the larynx and in the axilla. The difficulty in swallowing hindered its administration by the stomach. The formulæ used were, for insufflation, from one to five grains of iodoform with one-sixth to half a grain of acetate of morphia twice daily, and for inunction one part of iodoform to seven parts vaseline, also twice daily. When the larger doses of iodoform were reached, the patient became violent and quarrelsome, and a condition of excitement closely resembling the first stage of alcoholic intoxication was induced, which subsided on the discontinuance of the remedy. Considerable benefit to the local symptoms was experienced at the same time, but though the remedy was pushed as far as was conducive to safety, it was found that no effect was produced upon the bacilli of tubercle, which continued still to be found readily in the sputum. Inunction without insufflation also produced slight excitement and confusion of ideas. Previous to this case, I had already¹ directed attention to the toxic action of the drug, and though the views then expressed by me did not find favour with certain continental authorities,² further experience has confirmed me as to their correctness. Dr BATTY TUKE, who saw with me the case now under notice, has informed me that, soon after seeing my patient, he was called to another case, in which the free use of iodoform produced the same symptoms as those above described, which disappeared on the discontinuance of the use of the drug. M. MAITRE³ considers that, taken by man in doses of from five to six grains, it causes no notable symptoms; but my experience is that a smaller dose may readily induce toxic symptoms, particularly in weakly individuals.

With regard to the action of this remedy in laryngeal tuberculosis, although, probably by its anæsthetic action, it has a soothing effect on the throat, it does not seem to have any effect upon the disease. It does not

¹ Edinburgh Medical Journal, January, 1883.

² Centralblatt für klinische Medicin, 1883, No. ii.

³ Wood's Treatise on Therapeutics, p. 384. See also British and Foreign Medico-Chirurgical Review, Vol. XXXIV., p. 247.

diminish the number of bacilli in the laryngeal secretions, nor does it appear to promote the healing of the laryngeal ulcers. Little effect can, however, be expected from any remedies in such cases, unless use be made of them at very early periods of the disease, for its later stages are characterised by such an amount of laryngeal destruction and constitutional deterioration as invariably leads to a fatal termination.

Two cases with similar bacillary results after treatment by iodoform, have already been reported by me.¹ I have used the drug in about twenty additional cases of laryngeal or pulmonary phthisis, and have never found that it had the slightest apparent effect upon the bacilli or the disease. True, the patients occasionally improved to a certain extent, and, in some instances, increased in body-weight, but, as has already been shown in this work, this may happen in well marked cases of bacillary phthisis without the administration of any drugs whatever, and is consequently of little value as evidence in favour of the effective parasiticide action of the medicament in question.

Attention has lately been directed, first by BUCHNER,² to the probable value of arsenic as a bacillicide, by its supposed property of rendering the soil unfavourable to the growth of organisms, and as this drug is well known to be an antitriptic, this valuable combination, if existent, would probably prove of service in the treatment of bacillary phthisis. JACCOUD also recommends it both as a prophylactic and as a remedial agent. I have not made any observations of its effects upon the bacilli of the phthisical sputum, nor am I acquainted with the work of any other observer who has done so. Judged by its general effects only in phthisis, there appears to be a consensus of opinion that, however effective a tonic it may be, it has no specific effect upon the tubercular disease in man. It is interesting further to note that, according to RUEHLE³ chronic arsenical poisoning appears to act as an inducer of phthisis.

The action of alcohol in phthisis, and more especially its influence upon the expectoration and the bacilli of the disease, have not hitherto received due attention. By diminishing the amount of carbonic acid excreted by the lungs, and thereby promoting rest of the organs, and also by the tendency which

¹ British Medical Journal, Vol. II., 1884.

² Die ætiologische Therapie und Prophylaxis der Lungen-tuberculose, 1883.

³ Ziemssen's Cyclopædia, Vol. V., p. 491.

it possesses to induce fibroid changes in the viscera, it appears to be indicated in phthisis. I have not hitherto had opportunities of noting its precise effects upon the tubercular manifestations, especially the one which most concerns us at present—the sputum. Its alleged antiseptic action on the pulmonary secretion has been already referred to (p. 63).

The problem of affecting the germ of tubercle by either local or general medication has not yet been solved. Specifics do not exist, and attempts to alter the chemical composition of the tissues, such as the withdrawal of potash from the food, as suggested by HERMANN WEBER,¹ cannot be carried out to any extent, without injury to the individual. It is worthy of notice that, according to BAMBERGER,² potash is abundantly present in the catarrhal sputa, whilst soda is only sparingly to be found. The presence of potash, therefore, must be favourable to the settlement and development of the tubercle bacilli. But, as already stated, the problem is not to discover whether this or that substance will destroy the bacilli and their spores, but such a course of treatment, or such a medicine, which, while it blights the germs, will yet prove innocuous or even beneficial to their host. I do not now make any remarks in regard to the probable existence of antagonistic micro-organisms, as hinted at on pp. 10 and 72, as this is at present a mere hypothesis.

The conclusions arrived at in regard to the therapeutic indications afforded by the sputum in phthisis, may thus be summarised:—

In the early (pre-bacillary) periods of the disease, possibly characterised by the presence in the sputum of alveolar and bronchiolar epithelium, and probably also of elastic tissue in shreds, but without the presence of tubercle bacilli, benefit may be expected to result from preventive treatment, such as residence in a pure aseptic atmosphere, antiseptic inhalations, and separation from those actually phthisical. In the very early stages, with few bacilli in the sputum, there appears to be little doubt that the disease may be checked by the institution of appropriate hygienic, dietetic, and climatic treatment. When, however, the bacilli have obtained a footing

¹ British Medical Journal, 1885, Vol. I., p. 575.

² Riegel, Ziemssen's Cyclopædia, Vol. IV., p. 343.

in the lung and appear abundantly in the sputum, no amount or variety of medication, local or general, can with certainty be said to have the slightest effect upon them, and the same rule applies to climate, with the possible exception of cold, dry, and bracing atmospheres. The period of continuance of climatic treatment ought to be determined by the bacillary test frequently applied, and by this alone; all others may prove fallacious. The cases recorded in this work show that a very prolonged duration of treatment, by climate, is necessary, before the bacillary test indicates improvement. In considering the question of dryness, it ought to be borne in mind that, if the hygrometric conditions are too low (air too dry), an abnormal exhalation of moisture from the bronchial mucous membrane will result, with increased irritation and difficulty in expectoration. Renal functions being probably interfered with, the bronchial mucous membrane has to assist in the elimination of the effete products in the blood, and a condition of augmented irritation is thus induced. It is not to be denied, as above stated, that cases of bacillary phthisis do occasionally recover (Cases 15 and 16), but such an opinion is not incompatible with the view that the general tendency of tubercular (bacillary) disease is downward, and that as yet we have not been able to lay our hands upon a *certain* method of cure. The tiresome monotony of results which I have obtained induces me, so far as drugs are concerned, to take refuge in the treatment of symptoms, and, by alleviating cough, checking night-sweats, promoting digestion, mitigating fever, and regulating intestinal action, to endeavour to promote the comfort of the individual, and to assist in the curative efforts of nature.

CHAPTER XI.

THE THERAPEUTIC INDICATIONS OF THE SPUTUM IN LARYNGEAL AND ALLIED DISEASES.

WHEN the larynx alone is affected, the examination of the sputum may afford some important therapeutic indications. The general remarks which have been already made regarding the therapeutics of pulmonary diseases, apply to a considerable degree to those of the larynx also.

When the laryngeal secretion is defective or abnormally dry, nothing answers better than a spray or inhalation of carbolic acid. In the case of singers, or those who make great use of the voice, the mucous membrane of the larynx is apt to become dry, parched, and hyperæmic: in these instances a gargle or spray of iced water will frequently alleviate the disagreeable sensations, and allow the voice to be used with comfort and effect. Cold in such instances causes vascular contraction, and averts tumefaction. When, on the other hand, the laryngeal secretion is in excess, inhalations of cubebs are most likely to produce benefit.

Hæmorrhage from the pharynx or larynx ought to be treated radically by the direct application of the galvano-cautery. Failing this, astringent sprays, say, of iron, are amongst the most beneficial. Chloride of iron is rapid in action, and as it forms an insoluble compound with the albumen of the blood, it forms a sort of plug for the smaller vessels. In laryngeal cases, the spray ought to be applied by means of an instrument with a tube and nozzle sufficiently long to play directly upon the affected part. Insufflation of astringent or caustic powders may sometimes induce violent irritant action, or even hæmorrhage, unless carefully applied.

In putrid sore throat, with gangrenous sloughs in the sputum, and in parasitic disease of the mouth and tonsils, the use of antiseptic inhalations, washes, and sprays is strongly indicated. These may be composed of creasote, carbolic acid, or turpentine.

In tubercular laryngitis, with tubercle bacilli in the sputum and in the laryngeal secretion, dry inhalations are strongly contra-indicated, as being liable to irritate and aggravate the existing condition. In the early stages of the affection, when the laryngoscopic appearances closely resemble those of simple laryngitis, treatment ought to be directed towards subduing the accompanying inflammation, by means of sprays, powders, or pigments. In the later stages, with pain as a prominent symptom, local applications of a soothing nature ought to be applied internally and externally. For internal application, painting with a 5 per cent. solution of hydrochlorate of cocaine before attempting to swallow food is the best: next is morphia applied by insufflation in doses varying from one-sixth to one grain: then iodoform. As already stated (see p. 86), it is in vain to expect the latter remedy to have any curative effect upon the disease: it is anæsthetic and slightly antiseptic, and hence assists in mitigating pain and subduing fetor. External applications, which, in addition to covering the throat, should also embrace the ears, are best applied as hot fomentations with the addition of opium. When saliva is in excess in the sputum, which is frequently the case in the later stages of laryngeal phthisis, hypodermic injections of morphia or atropia are indicated.

In malignant disease of the larynx, such accuracy in diagnosis as can only be afforded by the microscopical examination of the sputum, or of pieces of the neoplasm artificially removed, combined with a careful laryngoscopic inspection, is requisite in order to decide the propriety and extent of surgical interference. In any variety of malignant disease tracheotomy may be performed, but the major question of radical treatment requires careful consideration of the precise nature of the neoplasm with which it is proposed to deal. The fallacy which may attach itself to the examination of detached pieces of the

growth, especially in its earlier stages, with laryngoscopic appearances closely resembling those of chronic laryngitis, and with detachment from its surface of pieces of granulation tissue, have already been referred to (Case 23). In the case there detailed, with the neoplasm confined to the interior of the larynx, without glandular implication, and notwithstanding its careful removal by Professor CHIENE, the disease returned in about six weeks' time, attacked the operation-wound, and finally appeared as an excrescence in front of the larynx, rather larger than a man's closed fist. It does not seem, therefore, that thyrotomy is of service in cases of unmistakably intrinsic carcinomatous disease of the larynx: the only question is, whether one ought to rest satisfied with the performance of tracheotomy, or should proceed to complete extirpation of the larynx. In cases of early sarcoma, according to the views of BUTLIN¹ it may suffice to remove the affected area of the larynx, or if the disease be advanced, the whole organ may be swept away, though even here recurrence may take place. In complex laryngeal affections, such as a commingling of syphilis, cancer, or tubercle, the therapeutic indications of the sputum are of great service to the practitioner. Further reference to this subject appears, however, unnecessary.

In benign neoplasms, the surgical indications are more decided. Some of these, it is believed, not only tend to recur, but to exhibit on each occasion of recurrence a gradual tendency to malignant degeneration. Microscopical examination assists in revealing this; hence the propriety of examining such pieces of the neoplasm as are found in the sputum, or are artificially removed, before deciding the question of surgical interference.

¹ Malignant Disease of the Larynx, p. 23.

CHAPTER XII.

DISINFECTION OF THE SPUTUM.

THE inability experienced by most observers to detect bacilli in the expired air of individuals in whose expectoration they are known to abound, renders it highly probable that the sputum is the medium of infection in phthisis. Tubercular disease may also be communicated by means of food; in this case it affects primarily the digestive system. As already observed, the sputa become dry and pulverised, their constituents, including the bacilli of tubercle, mix with other atmospheric impurities, and, while they thus obtain access to the lungs of all, gain a permanent footing in comparatively few, those with the so-called predisposition or tendency to the disease. From this point of view, therefore, disinfection of the sputum should be a matter of rigid practice. We ought, by close attention to ventilation and cleanliness, to endeavour to promote the atmospheric purity of the phthisical apartments, and by the use of parasitocides attempt to render innocuous the germs of the disease. It deserves to be known that experiments have proved the following methods to be effective in destroying the bacilli of tubercle. Boiling for five minutes kills them, as also does exposure for one hour to a temperature of 60° to 65° C., as well as immersion for twenty-four hours in a 5 per cent. solution of carbolic acid. It is uncertain how long these bacilli or their spores retain their virus after expectoration. I have found them in putrid sputum about one year after expectoration, but whether they were then capable of setting up tubercular disease I had no opportunities of testing. It has been shown, however, that they retain their infective properties for several months, probably from three to five, after expectoration. Under these circumstances the number of latent infective particles continually being wafted about our cities must

be enormous, and the marvel is, not that tuberculosis is the most prevalent of all diseases, but that it is not more common than is the case.

The simplest effective method for the destruction of these bacilli undoubtedly consists in the free use of carbolic acid. This substance may be volatilised by heat, and diffused throughout the apartments occupied by phthisical individuals, and not only should the expectoration dishes be freely supplied with fresh solutions, but all handkerchiefs and sputa-stained linen should be immersed and allowed to remain in them for at least twenty-four hours. By the adoption of these or some other equally efficacious methods, the organisms would undoubtedly be destroyed, and the risk of infection, which might otherwise continue for several months, would be entirely obviated.

CHAPTER XIII.

METHODS OF EXAMINING THE SPUTUM.

THE method of examining the sputum embraces two steps—the examination of the simple sputum, and its examination after the addition to it of certain colours or stains. Before proceeding to the microscopical examination, note the characters of the sputum in regard to amount, consistence, colour, odour, and deposits on standing. Part of the sputum ought always to be examined in water, which washes out and separates the plugs and casts already referred to as occurring in certain inflammatory affections.

The sputum may be examined microscopically, by simply spreading a little on a glass slide, covering it with a cover-glass, and examining it in the usual way with a power of about 300 diameters. Cells of various kind, shreds of elastic tissue, fungi, crystals, tube casts, and various extraneous particles or fibres may be readily seen in this way. Cells when present are usually scattered indiscriminately throughout the field, but the fibres of elastic tissue, when scanty, are more likely to be detected around or near the margin of the preparation, from being forced outwards by the pressure of the cover-glass. Micro-organisms cannot be distinguished in this way, with the exception of some connected with the process of putrefaction. This simple proceeding ought always to be the first step in the process of systematic examination of the sputum.

The epithelial cells of the sputum are of four varieties:—1. Pavement epithelium from the upper respiratory passages or from the buccal mucous membrane; these are of no diagnostic importance. 2. Columnar epithelium, from the general mucous membrane of the larynx, trachea, and bronchi; they are rarely present in any quantity in the sputum. 3. Pulmonary alveolar epithelium indicating, if abundantly present, the existence of

alveolar catarrh, and a probable tendency to phthisis. 4. Ciliated epithelium from the bronchial and nasal mucous membrane, seldom seen in the sputum. Pus and blood cells may be seen: they are of no special diagnostic importance.

Mucus corpuscles and fat cells and débris of no diagnostic importance are occasionally present. Fibres of elastic tissue may be seen, as already stated, either in the general field of the microscope, or, if scanty, around its edges. They may be rendered more distinct by adding to the preparation a few drops of a $33\frac{1}{3}$ solution of caustic soda, or by acting upon the sputum thus:—"Prepare a solution of caustic soda, about 20 grains to an ounce of distilled water. Collect all the patient has expectorated in twelve or twenty-four hours. Pour this, previously mixed and shaken with an equal quantity of the soda solution into a glass beaker, and boil it over a spirit lamp, stirring it occasionally with a glass rod. As soon as it boils pour it into a conical glass, and add four or five times the amount of cold distilled water. If the mucus is still gelatinous after boiling, you have either added too little soda, or not boiled it sufficiently. The cold water carries down to the bottom of the glass any lung tissue that may be present, where it forms a slight deposit in about a quarter of an hour; if no deposit is visible, put the glass aside for two or three hours. Remove the deposit with a dipping-tube, and examine. The lung structures will be often found clinging to hairs and other foreign bodies in the sputa" (FENWICK).¹

As a general rule, and in the great majority of cases, elastic tissue can be easily recognised by the examination of the simple sputum, or after it has been acted upon by the solution of caustic soda ($33\frac{1}{3}$ per cent.). Such tissue may appear as simple filaments, straight, curved, or coiled, or in bundles or leashes having a distinct alveolar arrangement. In excess, and with the outline of pulmonary air-cells, they usually indicate phthisical ulceration of the lung: they have, however, been found in various forms of laryngitis, in chronic bronchitis, bronchiectasis, and chronic pneumonia.

Fibres of hair, cotton and wool, and fungi may be seen; these are readily distinguished from those of elastic tissue by their

¹ Medical Diagnosis, p. 62.

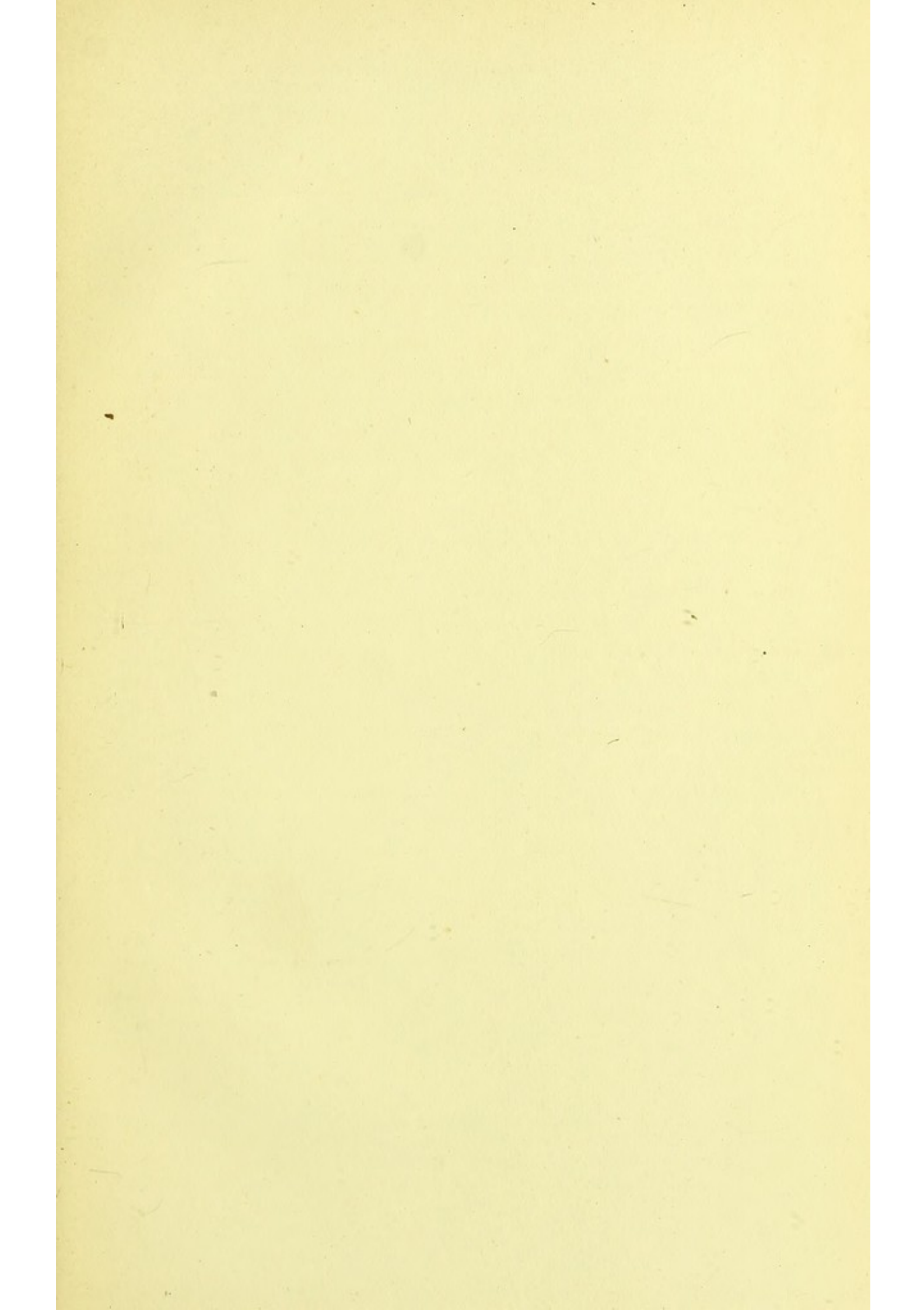




Fig. 32.—FUNGIOUS FILAMENTS (various) FROM THE SPUTUM ($\times 300$).



Fig. 33.—FUNGIOUS FILAMENTS (various) FROM THE SPUTUM ($\times 300$).
 Numerous fungi may be found in the sputa without having an etiological or diagnostic import.
 It is important to distinguish these from the fibres of elastic tissue.

appearances, as shown in Figs. 32 and 33.¹ The most common fungus is the leptothrix; it may be derived from the mouth or the lungs, in the latter instance being generally associated with putrid sputum.

Tube casts are present in fibrinous bronchitis and croupous pneumonia. Spirals (CURSCHMANN) are present in bronchiolar catarrh. These may frequently be recognised by the naked eye adhering to the sides of the expectoration glass; washing with water makes them more apparent.

Crystals may be:—1. CHARCOT'S crystals, insoluble in alcohol, ether, and chloroform; soluble in acids and alkalies. Their diagnostic import is uncertain. They were formerly supposed to have a causal relationship to asthma, but this has since been disproved.

2. Blood crystals—hæmatin and hæmatoidin; these occur as rhombic rods, or as needles arranged in tufts.

3. Fatty crystals—long, colourless needles, straight or curved, singly or in tufts or sheaves. They indicate putrescence. They are soluble in chloroform, alcohol, and ether.

4. Cholesterin, tyrosin—usually met with in putrid sputum.

Of all the constituents of the sputum now enumerated the most important are the epithelial cells of the minute bronchi and the pulmonary alveoli, and the elastic tissue in its varied arrangements. The presence of the former in abundance indicates such a catarrh of the minute bronchi and pulmonary air-cells as may precede the development of true bacillary phthisis. The latter holds second place in the diagnosis of phthisis, being only surpassed by the presence of bacilli themselves in the sputum.

In the further examination of the sputum, and in order to demonstrate the presence of certain pathogenic micro-organisms, as also of the non-specific schizomycetes, recourse must be had to the methods of staining, as introduced and popularised by KOCH and WEIGERT. These are as follows:—

Select the morning sputum, and place a small quantity on a cover-glass, spreading it out very thinly by rubbing two glasses together, or by means of a needle previously disinfected by heat.

¹ For further illustrations of the appearances presented by the constituents of the sputum, see Figs. 1 to 5.

Gently heat the cover-glass by passing it two or three times through the flame of a spirit lamp: a coagulated film will now be seen on the glass. So far, this is the first step to be adopted in the examination and staining of all micro-organisms; the subsequent steps differing according to the particular micro-organism, whose presence it is desired to detect. The principle, however, to which it is necessary to give effect in all cases is, to stain the preparation in such a way that the micro-organism is stained one colour, whilst the remainder of the preparation is differently tinted. Two stains or colours are therefore in use, one, the primary stain, to colour the micro-organism; the other, the secondary stain, to colour everything other than the micro-organism. To effect this, several methods of staining have been devised. After a fair trial of various methods, I venture to recommend the following as being the most convenient and certain in regard to results.

I. EHRLICH'S Method, as modified by GIBBES.—Here the two solutions used are, a solution of magenta (fuchsin) for the primary, and a saturated solution of chrysoidin or methylene-blue for the secondary stain.¹

Place the cover-glass, prepared as above stated and with the sputum downwards, in a watch-glass containing some of the filtered magenta solution, taking care that no air-bubbles are beneath the glass. Allow it to remain here for about half-an-hour. The bacilli are said to stain better if kept at a temperature of about 100° F., but I have not found this to be the case. On removing the preparation from the watch-glass, wash in a solution of nitric acid and distilled water, one of the former to two or three of the latter, until the superfluous stain is removed, which usually occurs in about fifteen to thirty seconds. The object in thus washing is, to drive the stain out of everything except the bacillus, which is done by the nitric acid. Then remove the adhering acid by washing freely in distilled water: this usually deepens the colour somewhat. Allow the preparation now to dry.

The second step in the process is to stain everything except the bacillus. This is effected by immersing the preparation for

¹ As the various stains for the detection of micro-organisms are now supplied by most scientific chemists, it has not been thought necessary to include their formulæ in the present work. Those used by the author were carefully prepared by Mr Hume, College Street, Edinburgh.

a few minutes in a second watch-glass, containing a filtered saturated solution of chrysoidin (brown) or methylene-blue. A few minutes suffices for this; the superfluous stain is then removed by washing in distilled water, and the process of drying is hastened by washing in absolute alcohol. Dry, mount in Canada balsam, and examine with a power of not less than 300 diameters. Bacilli of tubercle, if present, will be seen as minute magenta rods upon a brown or blue ground, according to the colour of the secondary stain employed.

The inability of some otherwise competent observers to succeed with this process of staining, and the prolonged attempts made by others before success is attained, induces me to make some observations upon the possible sources of error.

The morning sputum ought to be selected, especially if the bacilli are expected to be few in number. The act of expectoration ought to be spontaneous, as a voluntary cough is more liable to consist of a mere "hawking," or clearing of the throat. The bacilli are not diffused uniformly throughout the sputum; they are more likely to be found in the purulent than in the mucous portion. I have repeatedly found them from three to four times more abundantly in the former than in the latter. If the sputum is allowed to stand for some time, bacilli, if present, gravitate towards the bottom, and consequently are more liable to be found in the deposit. At least three preparations ought to be made before a negative observation is of any value.

The time allowed for the primary staining ought not to be less than from twenty to thirty minutes. If the washing with nitric acid be too prolonged, the stain will be driven out of the bacilli as well as out of the other constituents of the sputum. Distilled water ought to be used, if possible, though I have frequently succeeded with ordinary water. If much lime is present, the water, however, might affect the stain.

The method as now described, though at first sight somewhat tedious, is of easy accomplishment, and is the best for beginners. Those who are experienced in the recognition of micro-organisms may adopt the beautiful method of GRAM, which has this disadvantage that the primary stain is not communicated to the bacilli of tubercle alone, but to all other organisms which may happen to be present in the sputum. This method may be

employed for the detection of all varieties of micro-organisms, whilst that of EHRLICH is applicable to the bacilli of tubercle and of leprosy only.

2. GRAM'S Method.—The sputum is prepared on the cover-glass as in the first method. It is then placed in a watch-glass containing a preparation of filtered gentian-violet-aniline, where it is allowed to lie for two to three minutes. It is then washed in a solution of iodine 1 part, iodide of potassium 2 parts, and water 300 parts, which has the property of driving the violet stain out of everything except the micro-organisms. It is then washed in distilled water, and afterwards in absolute alcohol, which aids in driving out the superfluous stain. The secondary staining is accomplished as in the first method. In this way all the micro-organisms present are tinted violet, while the ground varies according to the colour of the secondary or contrast stain.

This method has the advantage of being more quickly accomplished than that of EHRLICH: it has, however, as already stated, the great disadvantage to a beginner or inexperienced observer of staining all the micro-organisms present. It is useful in detecting the schizomycetes of the sputum. The use of the secondary stain may be dispensed with in this method, as the iodine is sufficient to fix a brown contrast stain.

Amongst the constituents of the sputum which require more particularly to be distinguished from the bacilli of tubercle are the crystals of the fatty acids—palmitic and stearic acids, and tyrosin. Under magnification of 300 to 450 diameters, these crystals occasionally resemble the bacilli in outline and staining reaction. They are distinguished by their variable lengths, their frequent stellate arrangement, the variety of their shapes, and their solubility in alcohol, chloroform, and ether. WATSON CHEYNE¹ refers to a micrococcus, a torula, and the outer coats of some parasites as retaining the primary stain after washing with nitric acid (EHRLICH'S method), but the form and arrangement of the tubercle bacilli will readily distinguish them from those pseudo-bacillary forms.

¹ Practitioner, Vol. XXX., p. 257.

INDEX.

A.

	PAGE		PAGE
Abscess of Lung	7	Arsenic	87
Alcohol in phthisis	87	Artificial colouration of spu-	
ANDRAL, vicarious hæmop-		tum	48
tysis	60	Arytenoid cartilages in spu-	
Anthracosis	46	tum	50
Antiseptics	62, 91	Aspergillus in sputum	45
Apomorphine	62	Asthma	5
		Astringents	62

B.

BAMBERGER, potash in phthi-		Bronchitis, croupous	6
sis	88	Bronchitis, putrid	7
BEALE, organisms of mouth	47	BUCHANAN, dampness of soil	67
Benign growths of larynx	52, 92	BUCHNER, arsenic	87
Bone in sputum	47	BUHL, expectoration	13
Bronchiectasis	7	BUTLIN, laryngeal sarcoma	92
Bronchitis	5		

C.

Calculi in sputum	44	CHEYNE, WATSON, examina-	
Carcinoma of larynx	51	tion of sputum	100
Cartilage, arytenoid	50	CLARK, SIR A., fibroid phthi-	
Caseous glands	53	sis	10, 39
Catarrhal pneumonia	12	Climate in phthisis	68
Catarrhal sputum	3	Colour of hæmorrhagic spu-	
Catarrh, post-nasal	47	tum	58
Cells of sputum	5	Croupous bronchitis	6
CHARCOT'S crystals	6, 97	Crystals of sputum	5, 20

D.

DE CHAUMONT, epithelium		Diphtheria	48
in air	67	Disinfectants	62, 93
DELAVAN, malignant disease			
of larynx	52		

E.

	PAGE		PAGE
EHRlich, method of staining	82, 98	Epithelioma of larynx . . .	50
Elastic tissue	5, 20, 50	Examination of sputum . . .	95
Empyema	4	Extraneous matters in sputum	2

F.

Fetor of breath	8	FRÄNKEL, mycosis tonsillaris	48
Fibres of sputum	5	FRIEDLÄNDER, pneumo-coc-	
Fibroid phthisis	39	cus	14
FRAENTZEL, tubercle bacillus	43	Frothy sputum	4

G.

GAFFKY, tubercle bacillus . .	37	GIBBES, method of staining .	98
Gangrene of lung	7	GRAM, method of staining .	99
General remedies	81	GUTTMANN, phthisical spu-	
GERHARDT, rarefied and con-		tum	18, 21
densed air	63		

H.

Hæmoptysis, vicarious . . .	59	HASSALL, inhalation . . .	76
Hæmorrhage	54	HERTZ, hæmorrhage . . .	55
Hæmorrhagic infarction . . .	9	HERTZ, vicarious hæmoptysis	60
Hæmostatics	64	Hyperæmia of lung . . .	11

I.

Inhalations	62, 77	Iodine in sputum	6
Infective phthisis	58	Iodoform in phthisis . . .	82
Introduction	1	Iodoform, toxic effects . . .	82

J.

JACCOUD, arsenic in phthisis .	87	JUERGENSEN, pneumonia	
JACCOUD, creasote in phthisis	81	from embolism	9
JUERGENSEN, gangrenous spu-			
tum	7		

K.

KLEBS, diphtheria	48	KOCH, bichloride of mercury .	80
KLEIN, pneumo-coccus . . .	14	KOCH, method of staining .	97
KLEIN, tubercle bacillus . . .	29	KOCH, tubercle bacillus . . .	24

L.

LÆNNEC, classification of		Laryngeal lupus	53
sputa	5	Laryngeal syphilis	53
Laryngeal carcinoma	51, 91	Laryngeal tuberculosis . . .	49, 91
Laryngeal elastic tissue . . .	50	LEYDEN, alcohol in phthisis .	63
Laryngeal epithelioma	50	LEYDEN, cause of asthma . .	6
Laryngeal hæmorrhage	56, 90		

M.

	PAGE		PAGE
MAITRE, M., iodoform	86	MORGAN, prevention of phthi-	
Malignant disease of larynx	50, 91	sis	80
Measles	48	MÜLLER, chronic pneumonia	40
		Mycosis tonsillaris	48

N.

Nervous cough	18	Non-tubercular hæmorrhage	57
NIEMEYER, elastic tissue	21		

O.

Œdema of lungs	11	OERTEL, diphtheria	48
OERTEL, crystal formation	6	OERTEL, pneumo-mycosis	45, 65

P.

Parasiticides	65	Pneumonias	8
Pharyngeal syphilis	53	Pneumo-coccus	14
Pharyngeal tuberculosis	49	Pneumo-mycosis	45
Phthisis, calcuosa	44	Post-nasal catarrh	47
Phthisis, fibroid	10, 39	Prophylactics	66
Phthisis, pulmonary	17	Putrescent sputum	17
Phthisis, traumatic	45	Putrid bronchitis	7
Pneumonia from embolism	9	Putrid sore throat	48, 91
Pneumonia, croupous	12		

R.

RANSOME, bacilli in breath	30, 67	RUEHLE, arsenic in phthisis	87
Recovery from bacillary phthi-		RUEHLE, cretaceous sputum	45
sis	31, 76	RUEHLE, hæmorrhage	55
REMAK, pneumo-mycosis	45	RUEHLE, phthisical sputum	19
Remedial treatment	68		

S.

Sarcinæ in sputum	46	SÉE, GERMAIN, prognosis	37
SAWYER, calcium in phthisis	82	SIDEY, styptic application	64
Scarlet fever	48	Solvents	62
Schizomycetes in sputum	9, 15, 65	SOMMERBRODT, hæmorrhage	56
Sedatives	63	STERNBERG, pneumo-coccus	16
SÉE, GERMAIN, hæmorrhage	55, 59	Styptics	62, 64

T.

Temperature in bacillary		Tissue, elastic	5, 20
phthisis	32, 33	Tube-casts	5
Therapeutic indications of		Tubercle bacillus	24
sputum	61	Tubercle of larynx	49, 91
THOMSON, R.E., infective		Tubercle of pharynx	49
phthisis	58	Tubercular hæmorrhage	54
Thrush	47	TUKE BATTY, iodoform	86

V.

	PAGE		PAGE
Vicarious hæmoptysis . . .	59	Vomiting of blood . . .	59
VIRCHOW, sarcinæ in sputum	46		

W.

WEBER, HERMANN, potash in phthisis	88	WILLIAMS, bronchiectasis . . .	65
WEIGERT, method of staining	97	WILLIAMS, temperature in phthisis	34
Weight of body in phthisis . .	35	WILLIAMS, tubercle bacillus .	39, 67
Whooping-cough	16		

Z.

ZIEHL, staining method . . .	82	ZIEHL, tubercle bacillus . . .	43
------------------------------	----	--------------------------------	----





