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Name of author	Subject
[M]anchester Sanit'y [A]ssociation	First Annual Rep[t] 1864
"	Tests of Health of Tow[ns]
"	Adulteration of Food
"	Quarterly Report
[S]hrione	Ventilation by Syph[on]
[Co]rrespond' of Builder	Costless ventilation
Hill	Comparison of Vent. by pumping & extraction
Robertson	Hospitals
Cornish	Public Health
Morgan	Reservation of Mea[t]
Moule	National Health & Wealth
Menzies	Town drainage
Stenhouse	Filters in Sewers
Farr	Marriage on Health of French
Lawes & Gilbert	Comp. of Wheat
"	Feeding of Animals
Althaus	Trichinosis
Walls	Desinfection
Longmore	Recruits

43

ANNUAL REPORT

OF THE

COMMITTEE

ROYAL ARMY MEDICAL COLLEGE LIBRARY.

OF THE

MANCHESTER AND SALFORD

SANITARY ASSOCIATION.

BEING

A SUMMARY OF THEIR PROCEEDINGS FOR THE YEAR 1863.

APPENDICES:

NUMERICAL TESTS OF THE HEALTH OF TOWNS, REMARKS ON, BY ARTHUR RANSOME, AND WILLIAM ROYSTON, Esqrs.
APPENDIX DO. DO. DO.
ADULTERATION OF FOOD, REPORT OF THE SUB-COMMITTEE.
HEALTH OF MANCHESTER AND SALFORD, REPORT FOR THE THIRD QUARTER OF THE YEAR 1863, BY Dr. MORGAN.
Do. DO. DO. FOURTH QUARTERLY REPORT.

MANCHESTER:
POWLSON & SONS, PRINTERS, BOW STREET, JOHN DALTON STREET.
1864.

Bequeathed by Dr. E. A. Parkes.

At the ANNUAL MEETING of the Manchester and Salford Sanitary Association, held in the Town Hall, King Street, on Wednesday, 6th April, 1864:

THE RIGHT REV. THE LORD BISHOP OF MANCHESTER IN THE CHAIR.

The Annual Report having been read;

It was moved by MALCOLM ROSS, Esq.; seconded by Sir JAMES BARDSLEY; and supported by the Rev. T. B. STEPHENSON, B.A.; and resolved:—

That this Meeting, approving of the proceedings of the Committee as stated in their Report, requests that the said Report may be printed and extensively circulated.

Moved by ROBERT GLADSTONE, Esq.; seconded by MURRAY GLADSTONE, Esq.; and resolved:—

That the best thanks of this Meeting be given to the President, Vice-Presidents, Committee, and Officers, for their services rendered to the Association during the past year, and that the following noblemen and gentlemen be requested to act as President, Vice-Presidents, Committee, and Officers for the ensuing year, with power to add to their number.—(For the names see opposite page.)

Moved by WILLIAM FAIRBAIRN, Esq., LL.D.; seconded by Dr. Noble, M.A.; and supported by the Rev. J. P. Pitcairn, M.A.; and resolved:—

That as the physical well-being of the people is directly connected with their social and national advancement, the practical efforts of the Committee to induce attention to sanitary laws deserve the encouragement and pecuniary support of this Meeting and the public generally.

Moved by THOMAS TURNER, Esq., F.L.S., F.R.C.S.; seconded by THOMAS MELLOR, Esq., F.R.C.S.; and resolved:—

That, inasmuch as one of the fundamental objects of the Association is the prevention of disease, this Meeting trusts the Committee will use every means in their power to secure all possible precautions being taken to prevent the spread of infectious disorders.

J. P. MANCHESTER.

The Chair having been taken by WILLIAM FAIRBAIRN, Esq., LL.D.,—

It was moved by Sir JAMES BARDSLEY; seconded by ERNEST REUSS, Esq.; and resolved:—

That the cordial thanks of this Meeting be given to the LORD BISHOP of MANCHESTER for presiding on this occasion, and for the interest he always evinces in the success of the Association.

J. E. MORGAN, M.B., } Hon. Secs.
C. H. KNIGHT, }

MANCHESTER AND SALFORD SANITARY ASSOCIATION.

Committee and Officers for the Year 1864.

President:

The Right Rev. The LORD BISHOP OF MANCHESTER.

Vice-Presidents:

The Worshipful the MAYOR of MANCHESTER.
The Worshipful the MAYOR of SALFORD.
The Very Rev. the DEAN of MANCHESTER.
MARQUIS of HARTINGTON.
Hon. ALGERNON EGERTON, M.P.

Sir B. HEYWOOD, Bart.
Sir E. ARMITAGE.
Sir JAS. BARDSLEY, M.D.
Rev. Canon RICHSON, M.A.
THOMAS BAZLEY, Esq., M.P.
WM. ENTWISTLE, Esq.
W. FAIRBAIRN, Esq., LL.D., F.R.S.
A. H. HEYWOOD, Esq.
W. N. MASSEY, Esq., M.P.
J. A. TURNER, Esq., M.P.
JOS. WHITWORTH, Esq., M.Inst.C.E.

Treasurer:

Mr. E. REUSS.

Chairman:

Mr. THOMAS TURNER, F.L.S., F.R.C.S.

Deputy-Chairman:

Dr. NOBLE, M.A.

Committee:

Rev. T. R. BENTLY, M.A.
Mr. Councillor BOOTH.
Mr. J. BOUTFLOWER, F.R.C.S.
Mr. GEORGE BOWRING, M.R.C.S.
Dr. HENRY BROWNE.
Dr. F. CRACE CALVERT, F.R.S.
Mr. C. E. CAWLEY, M.Inst.C.E.
Mr. Councillor CHADWICK, Ass.Inst.C.E.
Dr. J. S. FLETCHER.
Rev. W. GASKELL, M.A.
Mr. GEORGE GREAVES, M.R.C.S.
Mr. WILLIAM HEATH, M.R.C.S.
Rev. G. HUNTINGTON.
Mr. J. W. JACKSON.
Mr. Councillor KING.
Dr. LANKESTER, London.
Dr. LEDWARD.
Mr. JOHN LOWE, Jun.
Mr. T. MACKERETH, M.B., M.S.
Mr. J. W. MACLURE, F.R.G.S., F.S.S.
Mr. H. M. MACLURE.
Mr. THOMAS MELLOR, F.R.C.S.
Mr. C. O'NEILL.
Mr. WM. RADFORD, M.Inst.C.E.
Mr. J. A. RANSOME, F.R.C.S.
Mr. A. RANSOME, M.A., M.B., M.R.C.S.
Dr. WM. ROBERTS.
Dr. ROSCOE, B.A.
Mr. WM. ROYSTON.
Dr. SAMELSON.
Dr. R. A. SMITH, F.R.S.
Rev. T. B. STEPHENSON, B.A.
Mr. C. A. SWINBURNE.
Mr. J. TEALE, M.R.C.S.
Mr. G. V. VERNON, F.R.A.S.
Dr. M. A. EASON WILKINSON.
Dr. WHITEHEAD.
Mr. W. J. WILLIAMS.
Rev. F. C. WOODHOUSE.
Mr. T. WORTHINGTON.

Honorary Secretaries:

Dr. MORGAN. | Mr. C. H. KNIGHT.

SUB-COMMITTEES.

FINANCE:

Mr. WM. BOOTH. Mr. E. REUSS, *Treasurer.*	Mr. A. RANSOME. Mr. ROYSTON.

LECTURES:

Mr. GREAVES. Mr. WM. HEATH. Mr. A. RANSOME.	Mr. REUSS. Mr. ROYSTON.

TRACT:

Rev. WM. GASKELL. Mr. GEORGE GREAVES. Rev. GEO. HUNTINGTON, M.A.	Rev. Canon RICHSON, M.A. Mr. G. V. VERNON. Mr. A. RANSOME.

REGISTRATION OF DISEASE:

Mr. GEORGE GREAVES. Mr. WM. HEATH. Mr. MACKERETH. Mr. A. RANSOME. Dr. ROBERTS.	Mr. WM. ROYSTON. Mr. J. TEALE. Mr. G. V. VERNON. Dr. WHITEHEAD.

INFANT MORTALITY:

Mr. GEORGE GREAVES. Mr. THOMAS MELLOR. Mr. J. A. RANSOME. Mr. A. RANSOME. Dr. ROBERTS.	Mr. WILLIAM ROYSTON. Dr. SAMELSON. Mr. J. TEALE. Dr. WHITEHEAD. Dr. M. A. EASON WILKINSON.

ADULTERATION OF FOOD:

Mr. WILLIAM BOOTH. Dr. CALVERT. Mr. KING. Mr. H. M. MACLURE. Mr. C. O'NEILL. Mr. A. RANSOME.	Dr. ROSCOE. Mr. WM. ROYSTON. Dr. A. SMITH. Mr. C. A. SWINBURNE. Mr. WILLIAMS.

COTTAGE DWELLINGS:

Mr. Councillor BOOTH. Mr. JOHN LOWE. Mr. W. RADFORD. Mr. A. RANSOME.	Mr. ROYSTON. Dr. SAMELSON. Mr. W. J. WILLIAMS. Mr. THOMAS WORTHINGTON.

The Chairman, Deputy-Chairman, and Honorary Secretaries, are, *ex-officio*, members of the above Sub-Committees.

REPORT.

IN presenting to their Subscribers and the public in general a Report of their proceedings during the year 1863, the Committee rest satisfied that the questions to which their attention has been directed are such as legitimately belong to a Sanitary Association, and that they have been worked out in a manner likely to prevent the spreading of infectious diseases, diminish the tale of death, and contribute to the general well-being of the community.

In looking back to the past year, the Committee feel pleasure in expressing their opinion that, though it must be confessed the state of the public health was not generally all that might have been desired, nevertheless this result was not owing to those exceptional causes which disturbed the industrial activity in the manufacturing districts. It is true that some remarks opposed to what is here stated appeared in their First Quarterly Report; at the time, however, that Report was published the tables of the Registrar General were not yet made known. These proved convincingly that, while the rate of mortality, generally, throughout the country was unusually heavy, the North-western division of England suffered less than many other places where wages were high, and the demand for labour steady and uninterrupted.

Of the diseases which contributed to the heavy death-rate, Scarlet Fever, Small-pox, and Typhus, all played a prominent part, and caused besides a vast amount of sickness and distress. From the first of these disorders the deaths amounted in the course of the twelve months in Manchester and Salford to 1,375, and probably the seizures to about 10,000. From the second, though the fatal cases did not exceed 166, the number of sufferers, many of them disfigured for life, may be estimated at upwards of 4,000. The latter disease, indeed, threatened at one time almost indefinitely to pursue its noisome track through every corner of the town and suburbs. When, however, the danger seemed imminent, the Committee, fortified by the statistics contained in their Weekly Returns, directed their best efforts to arouse the public to a sense of their danger, and, if possible, set some limits to its further diffusion. In promoting this object they addressed themselves to the authorities, requesting them to give effect to the power the law has vested in them of enforcing vaccination, and to order with all practicable despatch the removal of affected persons from the abodes of their friends. It was in this spirit that they applied to the Boards of Guardians of Manchester, Chorlton, and Salford; and to the gentlemen who constitute those bodies their acknowledgments are due for the polite attention they bestowed on their memorials. At the same time they solicited the interference of the Watch Committee in enforcing the regulations relating to the conveyance of persons suffering from infectious diseases in carriages let out on hire. An order conformable to this suggestion was speedily

promulgated among the cab drivers and omnibus conductors. The editors, also, of the more influential portion of the Manchester press were waited upon by the Honorary Secretaries, and requested to direct public attention to the precautions to be adopted. The Committee feel grateful to these gentlemen for the zealous and efficient manner in which they acceded to their wishes. And, that the reality of the danger might be rendered still more apparent, Mr. Arthur Ransome was requested to select extracts from a report on the subject of Small-pox, addressed to the General Board of Health in London by Mr. Simon, and to forward them to the daily papers. In the selected passages two points were especially insisted upon,—first, the extreme danger attending natural Small-pox; and, secondly, the highly satisfactory results which have been observed to accrue from revaccination. The salutary effect of these precautionary measures was soon seen in the abatement of the disease.

The Committee feel persuaded that the friends of the Sanitary Association will observe in the foregoing remarks a striking instance of the beneficial results likely to arise from the energetic action of a society constituted like their own. The statistics contained in their Weekly Returns supplied them at once with reliable information without which any unsupported assertions, however strenuously urged, had availed but little to stem the tide of popular apathy and neglect.

In June last the Committee, acting on a suggestion laid before them by Dr. Noble, passed a resolution requesting one of their Honorary Secretaries to draw up a weekly summary, based on the statistics contained in their return. About the same time they resolved to bring out at the end of the months of March, June, September, and December, a Quarterly Report. They believed that, in this manner, by more timely warning, the catalogue of preventible diseases might be considerably reduced; and, at the same time, the mass of valuable statistics accumulating in their returns would be turned to account, and assist in solving those obscure though doubtless not undiscoverable laws which regulate the ebb and flow of epidemic disorders.

The Committee further desire to congratulate the Association on two valuable papers, both contributed by members of their own body, and annexed to this Report. From such documents as these much valuable information respecting the state and requirements of our large towns cannot fail to be derived. The first appeared in the month of August, and was drawn up by Dr. Angus Smith; it is based on the chemical analyses of Messrs. Crace Calvert, O'Neill, Roscoe, Schunck, and Angus Smith, tabulated and arranged by Mr. O'Neill. These distinguished chemists, with a highly commendable generosity deserving the warmest acknowledgments of the Committee, devoted much valuable time to the analysing of those articles of food on which the poorer portion of the population more especially depend for their subsistence. The specimens examined were purchased by an officer of the Association in retail shops situated in the less wealthy districts of the town, and chiefly frequented by the labouring classes. The result of seventy-five analyses will be seen in the appended Report. They go to prove that, though it be true that dangerous adulteration is happily practised but rarely, nevertheless a fraudulent mixture of foreign substances, harmless indeed in themselves, is of decidedly frequent occurrence.

Another valuable paper, entitled "Fluctuations in the Death Rates of Towns," the joint production of Messrs. Arthur Ransome and William Royston, was published by the Association in the latter part of the year. The Committee would direct

especial attention to the able manner in which these gentlemen criticise the different methods pursued by various investigators in their endeavours to probe the state of the public health in towns and rural districts throughout the land. In clear and forcible language they point out the fallacies which in varying degrees mar the value of the conclusions arrived at, and the many disturbing causes which render trustworthy results with such difficulty attainable.

The following Lectures have been delivered during the year:—

LECTURER.	SUBJECT.	PLACE.
T. TURNER, Esq. F.L.S., F.R.C.S.	*The Connection between Food and Air, as Agents of Nutrition and Warmth*	St. Paul's School, Mulberry Street, Stretford Road.
Ditto	*The Importance of Sanitary Laws, and the Instinct of Self-preservation*	Temperance Hall, Grosvenor Street, Chorlton-upon-Medlock.
Ditto	*Animal Mechanics*	Mr Clark's Mill, Every Street, Ancoats.
Ditto	*Prevention is better than Cure*	St. Patrick's School, Livesey Street.
Ditto	*Animal Physics*	St. Michael's Institute, Hulme.
Rev. G. HUNTINGTON, M.A.	*Parental Responsibility in connection with the Physical and Moral Training of their Offspring*	St. Thomas's School, Ardwick.
Rev. E. B. CHALMER, M.A.	*Little Helps and Little Hindrances to Domestic Comfort*	St. Matthias' School, Broughton Road.
Rev. JAMES BARDSLEY, M.A.	*The Connection of Sanitary Arrangements with Social Comforts and Spiritual Feelings*	St. Peter's School, Fleet Street.
Dr. J. SHEPHERD FLETCHER	*Consumption,—Its Causes and Prevention*	Bennett Street School, Oldham Road.
Ditto	*Diet, Digestion, and Nutrition*	St. Matthias' School, Broughton Road.
Rev. J. DAVENPORT KELLY	*Out-door Exercises*	Bennett Street School, Oldham Road.
Dr. ALCOCK..........	*How to have Health in a Cottage*	Dr. Beard's School, Strangeways.

Lecturer.	Subject.	Place.
Dr. Leidward........	*Health, the Poor Man's Wealth*	Holland Street Ragged School, and Newton and New Islington Working Men's Institute.
Arthur Ransome, Esq., M.B., M.A., Cantab., M.R.C.S..........	*Bodily Strength—on what it Depends*	Infantry Barracks, Regent Road.
Dr. Roscoe, B.A.,F.R.S. Professor of Chemistry, Owen's College..	*The Air we Breathe*	All Saints' School, York Street, Chorlton-upon-Medlock.
Dr. F. Crace Calvert, F.R.S.	*Water as applied to Sanitary Purposes*	Town Hall, Salford.
Rev. W. A. Darby, M.A.	*The Unity of the Human Family*	St. Matthew's School, Camp Field.
A. W Dumville, Esq., F.R.C.S.	*Infanticide, or Child Murder*	St. Silas' School, Ashton Road.
Rev. St. Vincent Beechey, M.A.	*The Longevity of Man*	St. Phillip's School, Bradford.
Charles O'Neil, Esq., F.C.S.	*Chemistry of Animal Life* ..	St. John's School, Cleminson Street, Salford.
J. D. Morell, Esq. ..	*Health and Education*......	St. John's School, Miles Platting.
Rev. T. B. Stephenson, B.A.	*Houses and Houses*	Wesleyan School, Lyon Street, Bank Meadows.

The Committee desire to return their most sincere thanks to their Chairman, Mr. Turner, and those other gentlemen who, during the past year, rendered them able assistance by the delivery of lectures. They were attended by numerous and deeply interested audiences, amounting in the aggregate to fully five thousand persons. In accordance with the expressed wish of the Committee the subjects selected especially inculcated the observance of the more important sanitary laws so often neglected yet so deeply affecting the social and physical well-being of all classes of the community.

It is agreeable to observe that, during the past year, the sale of tracts and of cards was in every way satisfactory. Inasmuch as these publications are not thrust on the public, but spontaneously sought for and purchased, such a result cannot but prove a sign of encouragement and hope.

In July last Mr. Mackereth, of Eccles, who had kindly undertaken to edit the meteorological portion of their Weekly Return, was compelled by severe indisposition to relinquish the task. At this juncture Mr. Heap obligingly consented to arrange the report of the weather. To both these gentlemen they desire to express their acknowledgments and thanks.

The Committee further deem it right to bring before the notice of their friends a project pressed on their consideration by Mr. Arthur Ransome. It concerns the establishment of an institution for the training of nurses for Manchester and the surrounding neighbourhood. It is intended that a certain proportion of these nurses shall, after suitable instruction in their duties, discharge the office of district visitors among the poor, imparting to them useful information on such subjects as the training and management of children, and the preparation and cooking of food. Viewed under this aspect, the project appears to the Committee well worthy of their fullest encouragement and support. In so far, therefore, as their influence extends, no effort will be wanting on their part which can in any way add to its success.

In the death of Mr. M. Rowland Day, the late resident medical officer of the Royal Infirmary, the Association sustained a heavy loss. During the last four years he was a constant contributor both to the meteorological and disease columns of their Weekly Return. The Committee feel satisfaction in recording their grateful recollection of the importance of the services he devoted to their cause, and their deep regret at his early and lamented decease.

Before concluding their Report, the Committee once more desire to return their most sincere and grateful thanks to the various contributors to their Weekly Returns, for the continued readiness and zeal they evince towards the Association. To many of these gentlemen, actively engaged in the labours of their profession, it must frequently prove irksome to fill up by a given day a column devoted to statistics. Nevertheless the punctuality with which the work is carried out tends to show that in Manchester, whether among the members of the medical profession, the district registrars, or those who in their love of science devote much time to meteorological observations, there exists, on the part of each and all, a strong desire to contribute according to their several opportunities to the building up and diffusion of those great sanitary laws which, in proportion as they become more widely promulgated, cannot fail to promote the health, happiness, and prosperity, of these populous centres of manufacturing industry.

The Treasurer's account of the Income and Expenditure during the year is appended, and it shows a small decrease in the Subscriptions, as compared with 1862. By exercising great carefulness, and still further reducing the number of Lectures, the Committee have kept the expenses slightly below the receipts. The balance of the Tract Fund (£31 2s. 8d.) has been transferred to the General Fund, a much larger sum having been paid out of the latter for printing of Tracts, and the result is the balance in hand is rather more than at the same period in 1862.

ERNEST REUSS, ESQ., *Treasurer, in Account with the Manchester and Salford Sanitary Association,*

JANUARY 1ST, 1863, TO DECEMBER 31ST, 1863.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance in Bank, 31st December, 1862	31	15	5	By Rent and Taxes	37	0	0
" " " " Tract Fund	31	2	8	" Secretary's Salary	60	0	0
" Interest allowed by Bankers to 31st December 1863	2	13	1	" Commission allowed Collector	13	10	2
" Tracts sold	3	18	1	" Expenses attending Lectures	5	10	0
" Subscriptions	270	6	6	" Postages	13	3	6
				" Petty Cash, including Wages of Boy	19	7	10
				" Printing	111	18	6
				" Stationery and Books	4	1	2
				" Advertising	1	1	3
				" Office Furniture, &c	1	16	3
				" Balance in Bank	72	7	1
	£339	15	9		£339	15	9

Examined and found correct:

ERNEST REUSS.
WM. BOOTH.
C. H. KNIGHT.

Manchester,
December 31st, 1863.

MEMBERS FROM DONATIONS IN FORMER YEARS.

	£	s.	d.
Barbour, Robert, Esq.	10	0	0
Binyon Miss (Clifton)	5	0	0
Brooks, Samuel, Esq	5	0	0
Chadwick, R., Esq.	20	0	0
Coultate, E., Esq	5	0	0
Ellesmere, The Earl of	5	0	0
Gardner, Robert, Esq.	5	5	0
Gillibrand, P., Esq.	5	0	0
Heywood, E. S., Esq.	20	0	0
Heywood, Sir A., Bart	5	5	0
Heywood, Arthur H., Esq.	5	0	0
Heywood, James, Esq	5	0	0
Heywood, Oliver, Esq	15	0	0
Houldsworth, Henry, Esq.	10	0	0
Jones, R. Jennings, Esq.	5	0	0
Jones, W. C., Esq	5	0	0
Macintosh, Messrs. C. and Co	5	5	0
Manchester, The Lord Bishop of	10	0	0
Potters and Norris, Messrs	5	5	0
Plant, James, Esq	5	0	0
Schunck, Souchay, and Co., Messrs.	5	0	0
Spafford, George, Esq	5	5	0
Taylor, J. E., Esq	5	5	0
Todd and Coston, Messrs	5	0	0
Turner, J. Aspinall, Esq., M.P.	5	0	0
Watkin, W. B., Esq	10	0	0
Wood, W. Rayner, Esq.	5	0	0

SUBSCRIPTIONS.

	£	s.	d.
Ashton, Messrs. Samuel and Thomas	2	2	0
Ashton F., Esq	1	1	0
Atherton James, Esq	2	2	0
Atkinson F., Esq	1	1	0
Ashworth Joseph, Esq	1	1	0
Ashworth Thomas, Esq	1	1	0
Agnew Thomas, Esq	1	1	0
Atkinson and Gould, Messrs	1	1	0
Andrew Henry, Esq	1	1	0
Alcock, Misses	1	1	0
Amies Nathaniel Jones, Esq	1	1	0
Barbour, Messrs. R., and Brother	2	2	0
Brooks S., Esq	2	2	0
Barnes Robert, Esq	2	2	0
Bardsley Sir James L., M.D	1	1	0
Behrens, Messrs. S. L., and Co	2	2	0
Butterworth J., Esq	2	2	0
Bayley and Craven, Messrs	2	2	0
Bazley and Vernon, Messrs	2	2	0
Brown, Messrs. J., Son and Co	2	2	0
Butterworth and Brooks, Messrs	2	2	0
Bellhouse, Messrs. J. and W	2	2	0
Bury Henry, Esq	1	1	0
Bannerman J., Esq	1	1	0
Bannerman J. A., Esq	1	1	0
Browne Dr. Henry	1	1	0

	£	s.	d.
Brown William B., Esq	1	1	0
Booth William, Esq	1	1	0
Boutflower J., Esq	1	1	0
Barge Thomas, Esq	1	1	0
Buckley, Edmund, Esq	1	1	0
Bazley Thomas, Esq., M.P.	1	1	0
Bazley Henry, Esq	1	1	0
Binyons, Robinson, and Co., Messrs	1	1	0
Bright Messrs., and Co	1	1	0
Birks E. B., Esq	1	0	0
Barker N., Esq	0	10	6
Birch Rev. Edward, M.A	0	10	6
Bromiley Mr. Councillor	0	10	6
Bowman E., Esq	0	10	0
Booth Mr. Councillor (Salford)	0	5	0
Bolderson J. Junr, Esq	0	10	6
Carlton Messrs. J., Walker and Co	2	2	0
Carlisle Brothers, Messrs	1	0	0
Cunliffe and Sons, Messrs	1	1	0
Crewdson T. D., Esq	1	1	0
Carver, Brothers, and Co., Messrs	1	1	0
Crum, Walter, Messrs and Co	1	1	0
Calvert Dr. F. C	1	1	0
Capes W. H., Esq	1	1	0
Carver William, Esq	1	0	0
Clarke Daniel, Esq	1	1	0
Clayton J., Esq	1	1	0
Chadwick David, Esq	1	1	0
Compton, Joseph, Esq	1	1	0
Charlewood H., Esq	1	1	0
Cooke Thomas, Esq	1	1	0
Collins Edward, Esq	1	1	0
Chadwick John, Esq	0	10	6
Cawley C. E., Esq	1	1	0
Dugdale Messrs. John, and Brothers	1	1	0
D'Haurcgard Messrs., H., and Co	1	1	0

	£	s.	d.
Entwistle William, Esq	2	2	0
Elce Messrs. John, and Co	1	1	0
Fletcher Messrs., Son, and Co	2	2	0
Farbridge and Holliday, Messrs	1	1	0
Findlater and Mackie, Messrs	1	1	0
Fairbairn William, Esq	1	1	0
Franklin J. A., Esq	0	10	6
Fryer, Benson, and Forster, Messrs	1	1	0
Franks Abraham, Esq	0	10	6
Fullarton John Alexander, Esq	1	1	0
Gladstone Robert, Esq	2	2	0
Gardner Robert, Esq	2	2	0
Greg Messrs. R. H., and Co	2	2	0
Galloway Messrs. W. and J.	2	2	0
Graham Messrs. William, and Co	1	1	0
Galloway Messrs. J., and Co	1	1	0
Grover J. D. K., Esq	1	1	0
Gaskell Rev. William	1	1	0
Gladstone Murray, Esq	1	1	0
Gibb William, Esq	1	1	0
Gibson Rev. Canon	1	1	0
Greaves George, Esq	0	10	6
Harter William, Esq	2	2	0
Heywood Arthur H., Esq	2	2	0
Heywood Sir Benjamin, Bart	2	2	0
Heywood E. S., Esq	2	2	0
Heywood Oliver, Esq	2	2	0
Hunter Thomas, Esq	2	2	0
Hickson, Lloyd, and King, Messrs	1	1	0
Houldsworth H., Esq	2	0	0
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MANCHESTER AND SALFORD SANITARY ASSOCIATION.

REMARKS

ON SOME OF THE

Numerical Tests of the Health of Towns.

BY

ARTHUR RANSOME, M.B., B.A. CANTAB., M.R.C.S.,

AND

WILLIAM ROYSTON.

MANCHESTER:

POWLSON & SONS, PRINTERS, BOW STREET.

1863.

REMARKS

ON SOME OF THE

NUMERICAL TESTS OF THE HEALTH OF TOWNS.

It is the object of the present paper to examine the efficiency of some of the numerical tests of the health of towns, and to consider how far they will legitimately yield the inferences which have been drawn from them.

Most of these tests have been devised in order to guide those who are endeavouring by sanitary measures to raise the general standard of health of the inhabitants, and they have therefore been chiefly directed towards two ends:—1. To give a distinct and accurate account of the diseases and deaths occurring in various places; 2. To indicate the causes or influences by which these evils have been produced.

The first of these aids is essential to the sanitary reformer, both as a guide to the points where his help is most needed, and as a test of the efficacy of his measures. The second is equally important, since, before he can apply any remedy, he must know how the mischief has arisen.

In any enquiry into the health of towns these two objects should be kept carefully distinct. Without, therefore, in any way prejudging the question as to the origin of any excessive mortality, we will now examine some of the methods which have been used to ascertain the relative amount of disease and death prevailing in different places.

Since the year 1837, through the labours of the Registrar General and his staff, we have had a complete record of all the births and deaths which take place in this country. From these returns various methods of estimating the public health have been adopted :—

1. *The National System of Computation.*

This, which may be called the national system, was introduced by the Registrar General himself, and the striking results from it, which were published in his Sixteenth Annual Report, probably gave the first great impetus to sanitary effort.

By calculating the average number of deaths which occur in each town or district of the land for every thousand of its population the Registrar General obtained a series of figures which, varying from 15 to 36, he designated the "death-rates" respectively of the places for which they were received.

By means of these figures we could at once see the amount of mortality occurring in any particular place, and compare it in this respect with other places; or mark how far it departs from any ideal standard of health which we might have fixed upon.

At first sight it seems as if we had now gained all that we could desire, and many writers on sanitary subjects have assumed that with these numbers they could measure the health of various towns, as readily as they could by the thermometer ascertain their mean range of temperature.

So far, however, from being thus simple, the problem is one of a most complex nature, as we shall now endeavour to show.

There is one chief reason why we cannot, without further investigation, appeal simply to the death-rates of different places as tokens of their relative rank in the scale of health.—These places are not in the same position as regards the character of their population.

We will not now discuss the influence of particular employments, which more or less affect the public health in different localities, there is, however, another agency very frequently and actively at

work, which introduces serious errors into any calculations based upon the gross rate of mortality.

This disturbing element is to be found in the migratory character of a large part of the population of our large towns,—and it interferes with our calculations, both by altering the numerical proportions of the population at different ages,—and by assigning the origin of diseases to the wrong sources.

It is difficult for any one not acquainted with the fluctuating character of the population of large towns, to realize the extent of the migration that is continually taking place; the manufacturing towns are, in fact, constantly fed by immigrants from the healthy rural districts, and if it were not for this advantage, some of the most densely crowded towns would now be diminishing instead of increasing in numbers. It has been calculated by the Registrar General that the death-rate of Liverpool is lessened, from this cause alone, to the extent of six annual deaths per thousand.

The following table shows the proportion between the number of persons of various ages, at a country town, Brampton, and at Manchester :—

TABLE I.

Showing the per-centage of the population at the following ages, in Brampton and Manchester. The population used is that of 1851, and the deaths the average of the years 1850, 1851 and 1852.

	Under 15 years.	15 to 35 years.	35 to 55 years.	Above 55 years.
Brampton. Population 11,323	36·39	32·30	19·39	11·92
Manchester. Population 228,433	33·16	38·48	21·26	7·10

It will be seen that the per centage of persons under 15 is greater at Brampton than at Manchester; between 15 and 35 years of age, there are proportionately many more inhabitants in Manchester than in Brampton; from 35 to 55 the numbers are more equal, but from 55 and upwards Brampton again has the advantage.

This shows plainly that whilst from some cause Brampton is drained of its population between the ages of 15 and 35,—Manchester receives a large influx of persons at these ages.

Manufacturing towns will be most affected by this source of error, the migration to these centres of industry is much greater than to other places, and their death-rate is lessened in consequence; and therefore, any estimate of the healthiness of such places, based simply upon the gross rate of mortality, must be erroneous.

In the absence of any system of registration of immigrants, such as is practised abroad, it is impossible to obtain an accurate statement of the amount of fluctuation of population which is going on,—we must, therefore, seek for some other means of eliminating the errors which it introduces into the ordinary system of estimating the mortality of towns.

2. *Separation of the Mortality at different Ages.*

In a paper on the "Variation of the Death-rate in England," read before this Committee in 1860, instead of taking the gross mortality of a place and comparing it with the total population,—it was proposed to ascertain the number of deaths occurring at the various periods of life, and to compare these with the population then living at the same ages. In this way those ages most affected by the influence of migration are separated from the rest, and a more accurate comparison can be made between the mortality of different places.

For the purpose of testing this plan, the following table has been prepared. It shows the number of deaths which occur at Brampton and Manchester at the different periods of life. These deaths are estimated for every thousand of the population living at the several ages, and thus the deaths at each age are compared with the population at the same ages.

TABLE II.

The deaths at the following ages, for every 1,000 of the population at the same ages, at Brampton and Manchester:—

Towns.	Under 15 years.	15 to 35 years.	35 to 55 years.	Above 55 years.
Brampton	17·8	6·8	10·8	51·6
Manchester	47·5	9·9	23·3	86·2

The results are sufficiently striking. The ages least affected by the migration of the population, namely, from infancy to fifteen years, show the greatest difference in their rates of mortality; whilst those ages (from fifteen to thirty-five) which are most affected by this cause show its influence in an apparent approximation of the respective death-rates of the two places. When this table is compared with Table I., it can scarcely be doubted that the apparently small difference between the death-rates of the ages from fifteen to thirty-five years is caused by the influx of healthy lives into Manchester from such places as Brampton.

The method employed by the Registrar General is sufficient for ordinary purposes,—it will give the gross number of deaths occurring in any one town, and it will test roughly the progress made in the sanitary condition of the inhabitants; but when it is desired to contrast this town with others, greater exactness is needed, and we have to take into account the variation produced in the rate of mortality by the fluctuating character of the population.

Whenever great accuracy is required, therefore, in comparing the mortality of different places, we propose to cut off entirely from the calculation, those ages which are chiefly affected by migration, and to compare only the deaths under fifteen years of age.

Table III. gives the mortality under fifteen years of age for every thousand of the population under that age in the following towns. We would especially call attention to the low death-rates at these ages in the cities and country towns of Stafford, Lancaster, York, and Altrincham, as compared with those of Liverpool, Manchester, Sheffield, and Wolverhampton.

TABLE III.

UNIONS.	Population under 15 years 1861.	Deaths under 15 years 1861.	Rate per 1,000
Eastbourne	3,969	66	16·8
Stafford	8,221	162	19·7
Lancaster	12,686	270	21·2
Altrincham	14,251	349	24·4
Birmingham	87,533	2,249	26·7
Carlisle	15,813	492	31·1
York	19,925	624	31·3
Wolverhampton........	48,918	1,618	33 0
Exeter	10,678	357	33·4
St. George (H. S.)......	22,217	816	36·7
Sheffield	48,320	1,918	39·6
St. George (East)	17,044	701	41·1
St. Giles	15,643	714	45·6
Preston	38,467	1,797	46·7
Manchester	83,038	3,946	47·5
Liverpool	87,774	4,689	53·4

3. *The* $\frac{Death}{Birth}$ *Method.*

Another method of computing the death-rate of towns has recently been applied by Dr. Whitehead.* The result of his calculations is much more favourable to our city than that arrived at by the Registrar General. It, therefore, becomes very necessary that the mode of computation employed should be carefully examined.

* The Rate of Mortality in Manchester, by James Whitehead, M.D. 1863.

According to this method the number of deaths for every hundred births is assumed to be the "death-rate," and the proportion of deaths to births is made to measure the salubrity of places. Thus the figures in the following table are supposed to represent the healthiness of the places to which they belong :—

TABLE IV.

Number of deaths to every 100 births at the following places :—

Manufacturing Towns	$\frac{Death}{Birth}$ rate.	County Towns	$\frac{Death}{Birth}$ rate.
Sheffield..............	73·15	York	74·00
Wolverhampton......	67·19	Stafford	83·39
Manchester	72·71	Lancaster	81·00

This method appears to us to be founded upon an entirely fallacious basis; it takes for granted that the rate of increase is a fair test of salubrity; it compares the number of deaths with that of births, a standard constantly varying from causes independent of sanitary conditions: it avoids none of the errors belonging to other modes of calculation, and it imports several of its own.

1. The rate of increase from the excess of births over deaths is not a fair test of salubrity, even supposing the error from emigration and immigration eliminated. A very healthy place may remain, through a series of years, perfectly stationary as to population; through various causes not connected with salubrity the birth-rate may be equal or inferior to the death-rate—as is the case in many parts of France; such a place, however, would be immediately condemned by the mode of calculation which we are considering. If from any cause, economic or moral, the number of births should merely equal the number of deaths, a place might be most healthy, all the inhabitants might live to the age of 70, or even 100; and yet, according to this method of computation, it must be written down as most insalubrious,—it would have a rate of mortality of 100 or 24 per cent. worse than Manchester, with its $\frac{\text{death}}{\text{birth}}$ rate of 76.

2. In the $\frac{\text{death}}{\text{birth}}$ method, the standard of comparison chosen is itself variable, and has no necessary connection with the sanitary condition of a place.

The following table shows how greatly the birth-rate varies, even in the several districts of Manchester:—

TABLE V.

Showing the number of births per 1,000 in the following districts of Manchester:—

Chorlton............	34 per 1,000	St. George's	40 per 1,000
London Road ... } Deansgate ......}	36 do.	Hulme	42 do.
Ancoats	39 do.	Ardwick	43 do.

If we take the birth-rates of different towns, as shown in Table vi., the contrast is still more striking.

When the health-rate is obtained by dividing the deaths by the births, it is evident that an increase in the number of births will materially affect the result by increasing the denominator of the expression, and thus, wherever, from any cause the per centage of births to the population is greatest, there, cœteris paribus, the $\frac{\text{death}}{\text{birth}}$ rate will be less than it ought to be.

In proof of this, let us take an example:—In Ardwick, to every 1,000 of the population, there are 24 deaths; and in Chorlton, there are 19, showing a difference of 25 per cent. in their true rate of mortality; by the $\frac{\text{death}}{\text{birth}}$ rate, however, they are nearly equal, the deaths being respectively 56 and 57 to every hundred births.

The reason of this difference becomes at once apparent, when we find that the respective birth-rates of the two places are,—Ardwick 43, and Chorlton 33.

Without enumerating other causes of variation, economical, moral, or physiological, it is certain that the number of births depends in part upon the number of marriages, and this again upon the propor-

tion of individuals who are of marriageable ages—upon the condition of trade—the plenty or scarcity of the necessaries of life.

For these reasons manufacturing towns naturally show a more rapid rate of increase by means of births than either cities or country towns.

The following table shows the marriage rates for every thousand of the population in three manufacturing unions and three county unions or cities. It is interesting to compare with these marriage rates the number of births, and the rates of increase as shown by the $\frac{\text{death}}{\text{birth}}$ method, and to notice the relation existing between the different sets of figures:—

TABLE VI.

	Towns.	Population in 1861.	Marriage per 1,000	Births per 1,000	Deaths per 1,000	$\frac{\text{Death}}{\text{Birth}}$ rate
Cities and County Unions.	York	59,909	9·73	33·4	24·0	74·00
	Lancaster	35,297	7·22	32·7	21·8	81·00
	Stafford	24,475	7·09	29·2	20·7	83·39
Manufacturing Unions.	Manchester	243,988	18·11	38·1	30·4	72·71
	Sheffield	128,951	13·13	41·4	26·2	73·15
	Wolverhampton	126,902	7·24	40·5	21·8	67·19

Wolverhampton seems to be an exception to the rule that the number of births are proportionate to the marriage rates, but its $\frac{\text{death}}{\text{birth}}$ rate shows the influence of its large birth-rate, which exceeds even that of Manchester, notwithstanding the small relative marriage rate of Wolverhampton.

These circumstances explain the relative salubrity of large manufacturing towns, from this mode of reckoning. The frequency of marriages and births in these hives of industry, causes the $\frac{\text{death}}{\text{birth}}$ rate to be small; and thus those places which are really most unhealthy are made to appear to great advantage by the side of quiet country towns, where there is less marrying and giving in marriage, and where consequently there are fewer births.

We thus see that this novel mode of computing the health-rate of towns, not only gives an incorrect view of the comparative rate of mortality, but it exaggerates the errors due to immigration and migration.

4. *Average Duration of Life.*

It has been proposed to estimate the relative healthiness of towns, by comparing the average age at death of their respective populations.

The returns of the Registrar General give the age of each person at the time of his death, and thus furnish the materials for this calculation.

It will be evident, however, that all the errors due to immigration will be retained and even magnified by this method, since the ages at death of all new comers will be included amongst the other deaths.

An extreme example will show how fallacious this mode of calculation would be. An unhealthy military station—like Sierra Leone for example—might have its garrison constantly renewed by the arrival of fresh troops from England. These men might be killed off in a short time by the action of the deadly climate, and yet, since the ages of these soldiers would not be less than twenty to thirty years, the average age at death would be very high, and would consequently indicate a very healthy condition. Something of this kind must always be the case with immigrants into unhealthy towns.

We believe, therefore, that of the various tests which we have examined, the second alone can be relied upon to give trustworthy results. By calculating the mortality of that portion of the population

which is unaffected by migration we have a fair standard by which towns can be compared one with another and ranked in the scale of health. At the same time, however, we would repeat that, whilst we choose this as a means of comparison, we do not entirely throw aside the other methods which we have reviewed, only they must not be burdened with more inferences than they will safely carry.

The $\frac{\text{death}}{\text{birth}}$ rate, when compared with the Registrar General's gross rate of mortality, shows the speed at which large towns are increasing, in spite of the enormous number of deaths; and the average duration of life, when employed in the same way, gives us some idea of the classes of the population amongst whom deaths are most frequent.

The Causes of Death.

We may turn now to the second branch of the subject, and ask what help is afforded by the figures which we have obtained to guide us to the causes of the mortality of these places.

It has been the habit with certain writers on sanitary subjects to assume at once that the greater part if not the whole of the excessive mortality of large towns is due to want of proper sanitary conditions; and hence, without further investigation, a high death-rate has been held to imply an urgent need for physical sanitary reform; this once accomplished it is supposed that the mortality would immediately sink to a normal standard.

The ambiguity of the phrase—"the unhealthiness of a place," lends itself readily to such an assumption,—at one time meaning simply that there is a high rate of mortality there,—at another being intended to designate the condition of the town with respect to climate, drainage, or other sanitary conditions. Thus it is easy to mingle the two meanings, and to take it for granted that a high death-rate is purely the result of defective sanitary regulations.

Unfortunately the case is not thus simple,—we must, in fact, group roughly all the preventible deaths occurring in our large towns in two great divisions.

First.—Those which arise from defective sanitary arrangements, or from the essential physical insalubrity of the places themselves.

Second.—Those which are produced by the so-called moral causes from want of proper management of health on the part of the inhabitants themselves.

It is with the first of these sets of causes that the legislature and municipal authorities have to deal. We do not need now to enlarge upon their injurious action. Their effects, if not sufficiently guarded against, are at least tolerably well known,—bad drainage, air charged with noxious exhalations, crowded and ill-ventilated dwellings, unwholesome food or drink,—all these work their evil influence, not so much perhaps by producing actual disease, as by gradually bringing about that condition of low vitality which surely prepares the way for more active destroying agents.

We have to do with much more subtle causes of disease, and they must be sought for rather in the character of the inhabitants themselves than in the physical imperfections of the town.

We find but little indication of these causes in the tables of disease given by the Registrar General. From his annual return we could reckon the number of deaths which have been ascribed to various diseases, and those which had a specific origin, such as the numerous epidemic and syphilitic diseases, we might at once set aside as having no necessary connection with ordinary sanitary conditions. A pathologist might learn from them the number of times this or that organ of the body had been, or had seemed to be, the part chiefly affected at the time of death, and he might glean from them interesting facts bearing upon the history of disease, but this would be almost the sum of assistance to be gained by their study. The diseases of the liver would not tell of the intemperance by which they were for the most part occasioned,—the cases of infantile pneumonia would not accuse the parents of that careless exposure of their offspring by which they were probably produced.

If we want to track a large proportion of these deaths to their true sources, they must be sought for in the districts where they are most frequent,—in the back streets and crowded alleys of our manufacturing towns. And they do not lie far out of sight; we can readily enumerate the most common of the causes of disease and death, which are to be found at work in these places.

First, perhaps, must be named intemperance, not only as itself the cause of many diseases, but as a sure guide to all those which follow,—afterwards, in order, we might mention, the gross impurity of living, which has tainted the source of life at its origin, and which transmits hopeless disease as a heritage; the irregular habits which have cast an undue strain upon some one organ of the body; the unwholesome or improper food or drink, which have set wrong some of the many processes of nutrition; the toil unsuited to the age or strength of the worker; the daily struggle for existence, rendered all the more anxious, and weighing down the spirits and vital forces all the more heavily, from the want of providence for the future; the ignorance or neglect of the plainest laws of health, causing a want of cleanliness, or of any care for the body, and leading to reckless exposure to cold, damp or other noxious influences; over-crowding with all its train of evils; last, but chief cause of all, the want of care and want of knowledge of parents in the management of their children.

This is a list of some of the chief causes of death at work in our moral wastes, and yet, not one of them has any necessary connection with the sanitary condition of a place; scarcely one, which might not work its evil way as powerfully in the most salubrious as in the most unhealthy districts. It is the vast influence of these so-called moral causes of disease that should prevent us from drawing any conclusion respecting the physical sanitary condition of a place, simply from the magnitude of its death-rate. Our numerical tests cannot do away with the necessity for careful inquiry after the true sources of excessive mortality,—these must be sought in the habits of the people no less than in defective sanitary regulations

NOTE.—The following extract taken from the last Report of this association illustrates this conclusion very strikingly :—

"The condition of the streets in which the largest mortality occurred was then inquired into, but it was soon found that no valid conclusions could be drawn from a mere tabular statement respecting places in which the per centage of population at the various ages is not equal. The old streets are often inhabited by elderly people with grown-up families; the new chiefly by newly married couples, with increasing families. It was therefore resolved that several of the streets should be visited by members of the Committee, and inquiry made as to their condition and that of the inhabitants. Accordingly, several of the streets in New Cross Ward, Ancoats, were visited by Mr. J. A. Ransome and Mr. Royston, and a report presented to the Committee. These gentlemen found but little fault with the modern dwellings, but the houses forming the old streets were often in a very unhealthy condition,—the back passages and offices of these buildings being in many instances in a disgraceful state. It seemed probable, however, that the sanitary condition of the streets, so far as regards drainage and cleanliness, had less influence upon the health of the inhabitants than some other causes, and in support of this suspicion, the following table, presented by Mr. Royston, respecting two of the streets visited, shows that the mortality in the old streets was actually less than that in the new, and it also points out that this excess of mortality is due to the deaths of children—the birth-rate is greatest in the new streets, and the mortality is correspondingly large.

Deaths in 1859.

STREET.	Houses.	Populatn.	Deaths.	Rate per 1000	Deaths under 5 years	Rate per 1000	Deaths above 5 years	Rate per 000	Births in 1859	Rate per 1000
*Primrose-street. (old)	93	605	17	28	8	13	9	15	17	28
‡Cobden-street.. (new)	166	870	27	31	16	18	11	13	40	46

*16 Cellars.—6½ ⅌ House. ‡ No Cellars.—5¼ ⅌ House. 1861.

The larger number of deaths in particular streets, therefore, was no good guide in searching for special causes of unhealthiness, and after much consideration the Sub-Committee came to the conclusion that the chief causes of the large infant mortality of Manchester are want of knowledge and want of care in the management of children by their parents. It was resolved to attempt to meet these evils by issuing cards giving plain instructions to the parents in the subjects of "Food for Infants," "Clothing and Cleanliness," and on "Nursing Sick Children.

From the first this Association has fully recognised both the great groups of influences which we have mentioned as causes of the enormous preventible mortality of large towns. It has not only earnestly pushed forward all worthy schemes of sanitary reform, but it has also endeavoured to instruct the poor of this city in the laws of health,—both by the lectures regularly delivered each winter under its management, and by tracts, cards, and other publications constantly urging upon them the importance of temperance, cleanliness, and attention to the rules of health.

It has still a vast force both of physical and moral evil to contend against. There is still room for efficient legislative interference,—there is need both for the engineer and for the authority of the law, but, most of all, is there work for the sanitary missionary.

Overcrowding.

We have mentioned overcrowding among the other influences predisposing to disease.

The Registrar General has shown that the rate of mortality bears a close proportion to the density of the population, but this fact has recently been called into question in Dr. Whitehead's pamphlet already alluded to. There are, in fact, two modes by which the amount of crowding may be estimated,—one by calculating the number of persons to the acre — the other by noting the number of inhabitants to each house.

Now it is the excessive crowding of people in the same house from which we should expect injurious effects, and it is only by the second method that we can obtain an accurate idea of the extent to which this prevails. It is quite possible that a large number of persons might live in health, and without overcrowding upon a comparatively small area; or again, owing to the encroachment of other buildings, the inhabitants may be sparsely scattered over a large space, and yet the few dwelling houses remaining may be greatly over-crowded. The following table clearly shows that in the district of Manchester, therein displayed, the rate of mortality does not vary as the estimated average density,—but as the number of inhabitants per house.

TABLE VII.

Table, showing the acreage density of the population, the number of inhabitants per house, and the death-rate per 10,000 of the population, in the following districts of Manchester :—

Districts.	Population in 1861.	Estimated acreage density.	Average No. of Inhabitants per house.	Death-rate per 10,000 of Population.
St. George's ... Ancoats	104,038	19,796	5·6	280
London Road ... Deansgate ...... Market Street...	81,372	13,756	6·0	294

In truth it is not so much from the over-crowding itself as from the circumstances which accompany it that so many evils result from it.

The people who thus flock together most closely, are the poorest and most degraded of the population. They are driven by penury or by choice to the lowest parts of the town, generally to those parts which have been abandoned by all others from their proximity to the river, or to the various nuisances of a large town. They are thus left without the leaven of example to improve their condition, and become fit food for disease and vice.

These people are of that class, amongst which, we should be most likely to meet with all the evil influence, above mentioned, most actively at work. Amongst them we find intemperance, immorality, improvidence, neglect of the body, utter carelessness and ignorance of all the laws of health,—it is not surprising that amongst them death claims so large a proportion of victims.

Conclusions.

As the result of our enquiry therefore, we conclude,—

1. That the migration of persons from healthy districts into large towns, alters materially the proportions of the inhabitants at the

several periods of life, and causes an important variation in the death-rate.

2. That this variation, not being due to causes connected with disease, prevents any determination of the health of towns by a mere comparison of their respective death-rates.

3. That to obtain a typical representation of the mortality occurring amongst the fixed population of large towns, the deaths at those ages most affected by the fluctuation of the population must be separated from those which take place at an earlier period of life.

4. That the proportion which the number of births bears to the number of deaths, happening in any community, is no test of the healthiness of that place.

5. That the average age at death, in any town, is not a fair test of its salubrity.

6. That preventible deaths are not alone caused by defective sanitary conditions, but frequently, also, by want of knowledge and want of care on the part of the inhabitants.

7. That no conclusion, therefore, can be drawn respecting the sanitary condition of a town from a mere inspection of its rate of mortality.

8. That the instruction of the public, and especially of the poor in matters relating to health, is as important as the prosecution of sanitary reform by legislative and mechanical means.

Powlson & Sons, Printers, Bow Street, John Dalton Street.

APPENDIX.

Since the publication of this paper another edition of Dr. Whitehead's work has appeared, containing an explanation of his method of computing the death-rate. Upon this explanation we desire to make some further remarks,—first, however, noting that it leaves untouched the arguments which we have adduced against it.

First.—In the preface to this edition, and at page 46, an attempt is made to prove that the $\frac{\text{death}}{\text{birth}}$ method avoids the errors due to migration, as follows :—Certain towns are selected (Howden and Canterbury, Exeter and Ely), and the amount of migration affecting the populations of these places is calculated ; the numbers obtained are then added to or subtracted from the actual population, so as to produce a non-fluctuating standard. The average number of annual deaths is then compared with this population, and the result is found to tally much more closely with the $\frac{\text{death}}{\text{birth}}$ rate than with the Registrar General's return. In this calculation, however, a strange omission has been made ; the numbers of the migrants have been used to correct the populations, but no account whatever has been taken of the births and deaths which must have happened amongst them ; and thus, in one case, immigrants are deducted from a population, and yet their deaths are left to swell the apparent death-rate ; and, in another, emigrants are added to a population, without any addition being made to the number of deaths on account of the mortality which must have taken place amongst them.

If so erroneous a calculation produces results similar to the $\frac{\text{death}}{\text{birth}}$ rate, there needs no other proof of the faulty nature of this method of procedure.

Second.—Dr. Whitehead argues that the greater the excess of births over deaths, the more healthy is the place; and further, at page x. of the preface, and at page 65, he assumes that this excess of births over deaths gives the number of children who have been "safely reared through the casualties and destructive maladies of early age to maturity." We would simply refer to page 9 of our paper for a refutation of this doctrine.

Perhaps the fallacy of the $\frac{\text{death}}{\text{birth}}$ method cannot be better illustrated than by supposing a case, which is very little removed from many real ones: Two towns, each having a population of 10,000 souls, have, occurring amongst them during the same year, an equal number of deaths—240 for example. According to the national mode of calculation the rate of mortality would thus be the same in both places, but by the $\frac{\text{death}}{\text{birth}}$ method the death-rates will only prove equal if the number of births in each place are equal. Now we know that the birth rate varies considerably from causes quite unconnected with disease or death, and hence we might suppose that in one of these places only 300 children were born in the course of the year, whilst in the other 400 were produced. If this were so, then, by the $\frac{\text{death}}{\text{birth}}$ plan, the mortality in one place would be represented by 60, in the other by 80, or one-third more in one case than the other. A result, be it observed, wholly independent of sanitary conditions.

POWLSON AND SONS, PRINTERS, BOW STREET, JOHN DALTON STREET.

MANCHESTER AND SALFORD

SANITARY ASSOCIATION.

REPORT

OF THE

SUB-COMMITTEE

UPON THE

ADULTERATION OF FOOD.

MANCHESTER:
POWLSON & SONS, PRINTERS, BOW STREET.
1863.

SUB-COMMITTEE

ON

ADULTERATION OF FOOD.

Dr. ALCOCK,
Mr. Councillor BOOTH,
Dr. F. CRACE CALVERT,
Mr. GEORGE GREAVES,
Mr. Councillor KING,
Mr. H. M. MACLURE,
Dr. NOBLE,
Mr. Councillor OGDEN,
Mr. CHARLES O'NEILL,
Dr. ROSCOE,
Mr. WILLIAM ROYSTON,
Mr. W. H. SHAW,
Mr. EDWARD SCHUNCK,
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Ex-Officio.

Mr. T. TURNER, F.L.S., F.R.C.S., Chairman of the Committee.
Mr. C. E. CAWLEY, Deputy Chairman.

Dr. MORGAN, } Honorary Secretaries.
Mr. C. H. KNIGHT, }

REPORT

OF

THE SUB-COMMITTEE

ON THE

ADULTERATION OF FOOD.

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As several towns, including the metropolis, have taken advantage of the permission of the legislature to appoint a public analyst of substances used as food, it seemed to the members of the Manchester and Salford Sanitary Association that it might fairly be expected of them to enquire into the necessity of appointing such an officer for the protection of this population. Five chemists were requested to analyse certain specimens, which were bought for them by an officer of the Society. Purchases were made only from the inferior class of shops, but none of the names of the dealers were known or are even now known to the chemists who made the analyses. The object of the Society was not to detect the faults of individuals, but to ascertain the quality of the usual food of the poorer part of the inhabitants. The results were sent to the Association without remarks in nearly all cases, and Mr. O'Neill has collected them in a tabular form. I happened to send a short report, and, probably for that reason, have been requested to write one for the Association, grounded mainly of course on the analyses sent in. I say for that reason, because I have not made the subject a speciality, although a few details relating to it have been gradually accumulating during my stay in Manchester, and few chemists are permitted entirely to neglect it.

FLOUR.—The first specimen examined was flour. All agree in looking on this substance as in every case unadulterated. The specimen examined by Dr. Roscoe contained from one to two per cent of ash; but this was most probably intended for a brownish quality of bread. The specimen of flour examined by me contained 0·74 of ash and was seconds flour. It was of course carefully examined for alum but it contained none whatever.

I have lately had occasion to examine several other specimens of flour for a public purpose, and in few of them have I found alum. At first every one appeared to contain it, as a large amount of sulphuric acid was readily found; but, after a careful search, trying every method hitherto used, it was provéd that the acid only was present, and not the alumina generally. These flours were obtained under the suspicion of being adulterated with alum. The addition of sulphuric acid to the wheat before grinding seems largely to have taken the place of alum itself; and if it answers the ends desired— the prevention of further decay, it will be a valuable agent which can scarcely be suspected of doing any injury to counterbalance its services. The amount of sulphuric acid found is exactly the same as would exist in the amount of alum usually employed. If this has been obtained by experience, it is rather a singular circumstance.

BREAD.—Three of the specimens contained alum, and two were free from it. The amount generally found is fourteen grains per pound of bread. These results speak in favour of the flour dealers and against the bakers, and we can readily imagine that the baker comes into the closest contact with any quality of the flour that may be prejudicial to bread making. The alum is added to facilitate the rising

or fermentation, and the union of the gluten with water. It is however used also for the purpose of preserving the whiteness of the bread; this points rather to a *colytic* action of the alum, a power restraining decomposition. We know that alum has this preserving action; and, still more so, the poisonous salt sulphate of copper, which was formerly used for the same purpose.

Now Liebig has shown that a result similar to that caused by alum is obtained by the use of lime-water. It does not appear that the observations made by Liebig have met with due attention in this country. It has been objected to the plan that, although some of the advantages obtainable from alum are obtainable from lime, the increased whiteness is not one; but I am not aware of an extensive set of trials on this subject. If it be that the alum acts at a certain point by restraining the decomposition, and that the lime does not, we may perhaps obtain the same result by using lime and stopping the action of the fire at an earlier period, or by some other method to be found on enquiry. The whole subject is one affecting the most pressing wants of mankind, and all chemists must take their share of blame until it is made perfectly clear to the intelligence of persons of a very small amount of education. Until this be done we, the chemists, are more to blame than even the bakers of alumed bread; they solve the problem in the way best known to them,—we do nothing. We must however make Liebig and Dr. Dauglish exceptions. It may be advisable, on some occasions, to procure a satisfactory food for the people by threatening the dealers with the terrors of the civil law, but it is much more desirable to reach the same goal by the milder influences of natural law, as it is developed by science. This is the same as saying that chemistry will cure the evil better than the policeman, or that nature has more help in her than imperial parliament.

Professor Liebig's substitute for alum in bread.—" The action of both substances (sulphate of copper and alum) in the preparation of bread depends on their forming by heat a chemical compound with the altered and soluble gluten, by which the latter recovers all its lost properties of insolubility and its power to unite with water.

"The many properties possessed by the gluten of the cereals, in common with caseine, induced me to make some experiments with the object of replacing these two dangerous compounds by some other harmless substance with similar action; this substance is pure cold saturated *lime-water*. If the portion of the flour destined for the dough be made up with lime-water, and the yeast then added, and the whole left for some time, fermentation takes place just as if no lime-water had been used. On adding, at the proper time, the rest of the flour to the fermented dough, forming the loaf and baking as usual, there is obtained a beautiful, solid, elastic, highly porous bread, free from acidity and moisture, of most excellent flavour, and which is preferred to all others by those who have eaten it for some time. The proportion of flour to lime-water is 19 to 5: that is 100 lbs. of flour require 26 to 27 lbs. of lime-water. This quantity of lime-water is sufficient for the formation of the dough; common water must therefore be afterwards added in the proper proportions. (Lime-water is prepared by simply mixing freshly slacked lime with water, and letting it stand till it becomes clear: this is saturated water.") The exact amount of lime water is given here by Liebig; an experienced baker will know from the consistence of the dough if any more liquid is required, in which case ordinary water must be added; according as the acidity of the bread disappears salt must be increased to render it palatable.

"With regard to the quantity of lime in the bread we know that one pound of lime is sufficient for 600 lbs. of lime-water; if, therefore, the bread be made with the above proportions, the amount of lime will be nearly the same as in an equal weight of the leguminous seeds."

He also adds that the lime enables the bread to take up water to a greater extent, although it does not appear that this is a very valuable property when driven far.

Before leaving the subject, it may be remarked that no bread can be expected to be pure, in a refined sense, unless machine-made, and why that is so rare it is difficult to tell, considering that we

live among such an enterprising generation. Dr. Dauglish informs me that when his process of making bread is used, i. e. machine-made and ærated bread, "not only does it do away with the necessity to use alum, but the bread made with the soft and unstable flour prepared from soft English wheat is actually more pleasant to the taste and otherwise much better than when the expensive foreign wheats are used. Likewise the bread made from flour in which all the 'fine middlings' are retained is also more palatable and better, and I need not tell you far more nutritious than when the fine middlings are dressed out, which is always done for fermented bread making." He also says that, with his process, "alum is absolutely prejudicial," and "even flour which is harvested in bad weather makes a most delicious bread, without any addition of alum."

Oatmeal was not in any case adulterated. The specimen sent me was not well ground; the particles were unequal in size, so that there appeared to be more substances than one. There was also a large number of brown particles, arising either from some of the external husk, or, as is much more probable, from some admixture of foreign plants too often found in the oat-fields. Generally, however, the specimen was not clean; and, as a Scotchman, I may say, that it was hardly suited for porridge. I believe there are some nutritionary advantages connected with the use of this article of food, but it is not extremely attractive, and, when badly manufactured, it becomes repulsive, a condition more frequent than the contrary in England.

Sugar.—This article was found by Mr. O'Neill to be adulterated with starch sugar; the specimens sent to the other analysts were pure. Starch sugar is not unwholesome, but it has less sweetness than cane sugar, so that less value is obtained for the money. It is an adulteration employed for no other purpose than to increase the profit. It is a direct fraud without an apology, such as by some people is granted to the use of alum.

Pepper.—One specimen was adulterated. This was in part of really good material, but the whole was very weak, containing an enormous amount of starch and a material which seemed to be artificially compounded by mixing up a starchy material with water, then drying and breaking up into small pieces; one piece was as large as a pea. Another ingredient seemed to have been baked nearly black, and strongly resembled the husk of pepper; it contained little inorganic matter, 1·39 per cent. Here was a great and systematic adulteration, but it may not be injurious to health.

MUSTARD.—Two specimens were adulterated, one with wheaten flour and one with starch. Mr. O'Neill's specimen seems to have been very pure; mine was nearly all starch, and very slightly yellow. I have obtained the same for many years at one of the principal grocers.

PICKLES.—These were in no case systematically adulterated, as all the analysts believe, but in three cases copper was found in traces, in one case tin was found, and in another case lead; it is probable that the traces came from the vessels which were used. Dr. Schunck observed that the copper was not found in the liquid but in the solid, the same may be said of mine. It is better to use earthen-ware for all such acid liquids, metals ought not to be used, at least the precious metals only can be considered free from danger. Silver coatings are given by Messrs. Fryer, Benson, and Forster, to vessels in which fruit is boiled. It is scarcely possible to bring vegetable juices in contact with the ordinary metals without dissolving some, and iron is the only one which is safe when dissolved. Even tin, which is one of the least soluble metals, may be detected in an innocent mixture, such as bread and water, or milk, if it is put into a tin can and allowed to stand two or three days. As to copper, the ease with which it is taken up by liquids, which are as nearly neutral as liquids in nature generally are, is remarkable. As an instance of importance and of a kind not generally known I may mention that even a ball of copper, such as is used in cisterns for opening or shutting by its rise or fall the water tap, may give off as much copper to the water as will make itself perceptible. A curious case of this kind came under my notice; the water had been used for seventeen years and no one complained, but some one from a distance discovered metal

by his taste alone and refused to drink the water. This danger arising from the common apparatus of the cistern is, I think, a new one; but people are so differently affected that probably the small amount alluded to would not affect unpleasantly more than one occasionally. It may be supposed that I am a little wandering from the subject, but it is a useful thing to observe here and to prove by examples that it is not an unnecessary labour to seek out even minute adulterations in food. If the senses can detect quantities so small as those to which I allude, we may be certain that the chemical agents within us will not be behind.

VINEGAR.—This substance seems to have been the purest and best of the specimens, as it was in two instances at least, as mentioned by Drs. Schunck and Roscoe, above the average in strength as well as free from impurity. That sent to me was suspicious, it was weak, having only 1·55 per cent. of dry acid, and 0·16 in about 10 per cent. was sulphuric. Again, however, we must remark no poisonous adulteration; we can scarcely attribute any blame to this small amount of sulphuric acid even if it were free, which it is difficult to prove.

TEA.—Dr. Calvert's specimen was artificially coloured; no other adulteration is reported, nor is the nature of the colouring matter said to be poisonous.

The specimen sent to me as mixed tea contained ten to fifteen grains of green, the whole of the remaining portion of the two ounces being black. The name "mixed tea" is therefore correct abstractly considered; but, taking it as persons in general would understand it, it is a fiction. This is a subtle method of deceiving, and one that is extremely effective; an additional price is asked for the tea, and is obtained at little trouble or expense. There was a little "facing" as it is called on the green tea, but only to make it more beautiful; the tea was in reality green. Many persons are inclined to think that there is no such thing as green tea, the accounts concerning it have been so contradictory; but the action of the two on the brain or the nerves is so different that he must be extremely fortunate who is not sufficiently sensitive to perceive that there are two entirely different qualities in the green and black. This so-called mixed tea was not an adulteration but a deception certainly.

Coffee.—Three specimens contained chicory, two were free. Dr. Schunck found equal quantities, Dr. Calvert found beans, and Mr. O'Neill a fatty substance, in addition to the chicory. That sent to me was pure and good.

Cocoa.—Was in four cases out of the five adulterated with starch; Mr. O'Neill finds sugar also, and my specimen contained a mineral substance, consisting in a great measure of oxide of iron, still the amount was not great. It was added to give the reddish colour of which the starch had probably deprived the cocoa mixture. The total amount of mineral matter was 2·54 per cent.

Butter.—Of this substance there are only three reports. No adulteration is mentioned, except water, which exists in Dr. Roscoe's specimen to the extent of twenty per cent. It is very difficult to obtain good butter about this district,—salt butter is washed fresh and is mixed with really fresh new butter. The possibility of detection is avoided, no chemical experiment can discern such frauds; a delicate taste and smell form the best reagents. A qualified analyst or inspector of food ought to possess senses of great refinement. If the evidence of his senses, unaided by experiment, be not considered enough before a court for the conviction of any man, it is at least valuable as a guide in his own enquiries; sometimes it is the only evidence and must be taken.

Beer.—Was not adulterated. Mr. O'Neill found five per cent. of alcohol in his specimen, Dr. Roscoe six per cent.

Whiskey.—Mr. O'Neill finds to be made from an inferior grain, and Dr. Roscoe finds dissolved malt.

Gin.—Seems only to have been adulterated with water. It might here be remarked that an adulteration of this kind is very much to be admired, but it is not so; some little evil is done by the variation in strength, as those who are accustomed to the weak may greatly

damage themselves when coming to the strong, and it is a fraud unquestionably.

Brandy.—Dr. Calvert finds this spirit adulterated with methylated spirit; Dr. Roscoe finds a common spirit coloured with burnt sugar and flavoured with dried plums; and Mr. O'Neill a concocted British brandy.

No specimen of Milk was sent, and yet I have had specimens adulterated with four to six times their volume of water, and sold in the open market. Here water is a positively deleterious, I may say deadly, substance; children are supposed to be obtaining nourishment when they are merely starved on water.

Mr. O'Neill in summing up says,—"The result of my examination of the articles on behalf of the Manchester and Salford Sanitary Association, and of my private practice as well, tends to show that the adulteration of food with pernicious substances is very rare indeed; the adulterations or mixtures practised in coffee, cocoa, bread, and some other articles, are generally known to the public, or in fact called for by them. Although I think it very desirable that there should be an analytical officer appointed in large towns for facility of reference, I cannot give the opinion without at the same time remarking that as far as my practice enables me to speak there has been an unnecessary amount of alarm created in the public mind by the exaggerated statements of the extent of adulteration."

To this I may add that, although the dangerous adulteration is small, the amount of actual adulteration is great: amongst seventy-five articles examined seventeen are adulterated; five, the pickles, have impurities of a very poisonous character, although in small quantities; four, the breads, have impurities in greater quantity, although of a less poisonous quality, and three breads out of five contained alum.

We may say then that the conclusion to be drawn from the results sent by the chemists, and acquiesced in by these gentlemen, is that dangerous adulteration of food is not extensively practised in Manchester; but to this must be added that fraudulent practices connected with food are frequent. Are we to conclude then that the agitation on this subject has been entirely unnecessary as regards this city? and that the care which the legislature has shown by its enactments for the well-being of the population in the matter of pure food has been caused simply by needless alarm? To both these questions I would answer; no. My belief is that the agitation has been of incalculable value; the whole nation has been taught by one great enduring and well impressed lesson the value of purity in its diet, as it had previously, by the investigation into the health of towns, been taught the value of general cleanliness, and of purity of air. This result is enough of itself to justify the agitation, even if purer food be not yet obtained; but I believe firmly that it has been obtained. Unluckily we have no series of investigations of an earlier date relating to Manchester specially; but, as far as my own experience is concerned, I may say that when I came to Manchester I found flour containing several per cent of sulphate of lime in a considerable number of cases, lately I have found none. I found sweetmeats glaringly adulterated with as much as 40 per cent. of sulphate of lime, lately not so. I did not make an extensive investigation and cannot speak with that great knowledge which renders Dr. Hassall's and Dr. Letheby's opinions so valuable, but such as my experience has been it is right to give, since no one comes forward as commissioner for this district. We cannot refuse to attribute much of this result to the labours of Dr. Hassall and the Lancet, added to the increased knowledge of vegetable and animal chemistry which has grown as a magnificent harvest from seed sown by Liebig in this country, which he chose as the most fertile soil for his ideas. We must not however forget that the flour and corn merchants claim a right to some of the credit for organising a committee for pursuing defaulters with vigilance; this is a meritorious act of which the public does not seem aware.

Regarding the Act of the Legislature it may be said that it was, to a great extent, an embodiment of the feeling of the country on the subject, and is of great value, were it only from the fact that

it recognises official supervision. I shall not attempt to criticise the general working of the Act, but something must be said concerning the propriety of taking advantage of its permission to appoint an analyst here. It would appear that little advantage will be derived from an analyst who is not also an inspector. It does not seem sufficient that an analyst should be appointed who shall perform whatever work is sent to him by individuals, even at a low price. This throws the care of its food on the public itself, but the use of an Act is greater when it throws the care on some specially appointed person who shall both be the eye and the hand. It seems as if an individual might accomplish all that is required for the whole of South Lancashire, or some such district. It is scarcely fair to appoint one merely for towns when the villages are most in danger; and it is useless to the poor to appoint one for them if they are expected to call him in and pay his fee, no matter if that fee be only a penny. They have not the time to attend courts, and they don't understand the mode of conducting an enquiry. The objection to such an officer has been that he would be unwilling to go round acting as an informer, and that no scientific man could endure such a post. My belief is that to inform would be one of his rarest duties; that is, to inform a magistrate. He would only inform the dealers, the retail chiefly, and they would be glad of his advice; they would not dare to oppose his opinion, and they would gladly seek markets which would not bring them into disgrace. His information would be private, unless it were neglected, and these cases would I think be rare. The reports would be made to the authorities who appointed the analyst, and discretion used in the use of names. In most cases suppression of names would be unnecessary, because no man need be ashamed of selling that which he believed to be pure. The wholesale dealers are not very numerous, and would soon learn the value of precautions; if not, it would be those chiefly who would be informed against, and that not until properly and privately warned. A judicious man might in this way purify the food of a whole county.

By the *act* the county has a right to appoint an analyst, and the villages and hamlets might receive the benefit as well as the large cities. This would be an inexpensive establishment for each town and would be an actual protection, instead of a mere permission such as we now have. At present the act says: guard yourselves, there is a policeman who will help you if you pay him.

I am more inclined to take this view from observing the mode in which public information takes hold of individuals in every corner of this country. The whole nation frequently thinks on one subject in a similar manner, and at one time, and becomes thoroughly acquainted with it, a little care is wanted merely to keep alive the thought. Purity of food will be obtained by calling the attention of the public to it by occasional acts here and there, better than by the daily prying inspection into every individual shop. One man with a large district and a wide field of observation will be more valuable than very many who shall irritate by frequent interference, and rather provoke to opposition instead of assisting. The inspector would, in fact, gradually lift up the trader, by keeping alive both his sense of honour and his desire for security. At present the milk of which I spoke may be sold with impunity; who is to inform, even if an analyst were appointed? I see no value in an analyst without active inspection. We look on the adulterations here proved to be smaller than expected; and, considering the dangerous materials which the chemists were prepared to find, the result is most pleasing; but we must not forget that, after all, the report shows a very large amount of fraud. The deep vice which would allow a man to mix poison with the food of his neighbours is not to be found here. A higher civilization has produced a greater watchfulness in the public, and a milder form of crime in the trade. It is this watchfulness that ought to be cultivated, and its public embodiment in an officer would tend to its perpetuation.

R. ANGUS SMITH.

POWLSON AND SONS, PRINTERS, BOW STREET.

Results of Microscopical and Analytical Examination of Articles of Food purchased in Manchester.

NOTE.—The various articles were purchased by an officer of the Manchester and Salford Sanitary Association, from shops supplying the working classes in different parts of the town. The analysts then examined the articles and made independent reports of them, which are here tabulated.

Of each article reported on there were five distinct samples, obtained at as many different shops, thus making eighty samples which have been examined.

ANALYST.	PEPPER.	MUSTARD.	VINEGAR.	PICKLES.
Dr. CALVERT ..	No report	Not adulterated..............	Not adulterated..............	Contains traces of lead.
Mr. O'NEILL ..	Not adulterated	Not adulterated..............	Not adulterated..............	Contains copper and zinc.
Prof. ROSCOE ..	Not adulterated	1. Not adulterated.*—2. Adulterated with wheaten flour.	4·7 per cent. of acid and free from sulphuric—not adulterated.	Not adulterated.
Dr. SCHUNCK ..	Not adulterated............	Not adulterated..............	4½ per cent. of acid above average—not adulterated—quite free from sulphuric acid.	Trace of copper in the solid, not in the liquid.
Dr. SMITH	Adulterated	Starch chiefly	Not adulterated, but below average strength 1·55 dry acid.	Minute traces of copper, not in the liquid.

* Another sample was found largely adulterated with wheaten flour.

REMARKS.—The small traces of metals discerned in the pickles are attributed by the analysts to the metallic vessels in which they were prepared, and is an evidence of carelessness rather than fraud.

ANALYST.	FLOUR.	OATMEAL.	BREAD.	SUGAR.
Dr. CALVERT ..	Not adulterated..............	Not adulterated..............	Considerable quantity of alum..	Not adulterated.
Mr. O'NEILL ..	Not adulterated..............	Not adulterated..............	36 per cent. water—potatoes—no alum.	Adulterated with starch sugar.
Prof. ROSCOE ..	Not adulterated..............	Not adulterated..............	48 per cent water—contains tolerably large amount of alum.	Not adulterated—quality fine.
Dr. SCHUNCK ..	Not adulterated..............	No report	Not adulterated—no alum......	Not adulterated.
Dr. SMITH	Not adulterated..............	Not adulterated, but not prepared well or cleanly.	Alum 9·59 grains per lb.	Perfectly pure.

ANALYST.	BEER.	WHISKY.	GIN.	BRANDY.
Dr. Calvert	Not adulterated	Not adulterated	Not adulterated	Adulterated with methylated spirit.
Mr. O'Neill	5½ per cent. alcohol—not adulterated	43 per cent. alcohol—an inferior grain spirit.	32½ per cent. alcohol—not adulterated.	43 per cent. alcohol—a concocted British brandy.
Prof. Roscoe	6 per cent. alcohol.—not adulterated	38 per cent. alcohol—not adulterated, but has some malt in it.	30 per cent. alcohol—not adulterated, except with water	48 per cent. alcohol—a common spirit, coloured by burnt sugar and flavoured with dried plums.
Dr. Schunck	No report	No report	No report	No report.
Dr. Smith	No report	No report	No report	No report.

ANALYST.	MIXED TEA.	COFFEE.	COCOA.	BUTTER.
Dr. Calvert	A mixture with artificially colored leaves.	Mixed with chicory and perhaps beans.	Not adulterated	Fair quality.
Mr. O'Neill	Not adulterated	Great deal of chicory and fatty substance.	Chiefly potato starch and sugar	Not adulterated.
Prof. Roscoe	No report	Free from chicory	About 50 per cent. potato starch.	More than 20 per cent. water.
Dr. Schunck	Not adulterated	Mixed coffee and chicory, equal quantities.	Adulterated with starch	No report.
Dr. Smith	So little green that it is unfairly called mixed.	No chicory—not adulterated	Adulterated with starch and a mineral colouring matter.	

MANCHESTER & SALFORD

SANITARY ASSOCIATION.

REPORT

OF THE

HEALTH

OF

MANCHESTER & SALFORD

FOR THE THIRD QUARTER OF THE YEAR 1863;

Compiled from the Weekly Returns of the Sanitary Association, and presented to the Committee.

MANCHESTER:
POWLSON & SONS, PRINTERS, BOW STREET.
1863.

QUARTERLY REPORT.

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SUMMARY.

THE WEEKLY RETURNS of the Manchester and Salford Sanitary Association have now regularly appeared for upwards of three years. During all this time the numerous contributors, on whose voluntary and altogether unpaid assistance the Association is dependant for its reports, have in no single instance failed to supply the required information. To these gentlemen, no less than twenty-seven in number, all members of the medical profession, and all connected either with Public Hospitals or Poor Law Districts, the grateful acknowledgments of the Association are justly due for the time and labour they have bestowed in furnishing, week after week, full and carefully compiled returns respecting the number and nature of the new cases of disease that may have fallen under their notice in their respective districts.

The whole series of weekly tables, originally started on the 4th of August, 1860, at the suggestion and through the exertions of Mr. Arthur Ransome, the late Honorary Secretary, is thus in every respect full and complete.

Moreover, in addition to the medical contributions, several other gentlemen carefully record and kindly supply to the Association a series of weekly meteorological observations, and so the extent to which the ebb and flow of epidemic diseases appears dependant upon varied atmospheric influences may be readily seen and determined.

The Registrars, likewise, of eleven districts of Manchester and Salford, districts containing in the aggregate a population of upwards of 420,000, obligingly furnish the number of births and deaths they may be called upon to record, and from these latter returns a series of quarterly mortality tables has been carefully drawn up and tabulated by Mr William Royston.

It will thus be seen that, during the last three years, a vast amount of valuable statistics has been accumulating,—statistics from which the rise and fall of epidemic diseases may be traced—their intensity measured—and the particular districts in which they may have occurred may be pointed out, and attention directed to the conditions under which they appeared to have originated. With a view of turning this information to greater account, it is at present proposed to analize and briefly comment upon these weekly tables at the end of every three months, and to bring out the results in the form of a short Quarterly Report. As the materials for these reports will be deduced from the thirteen preceding returns, they will terminate with the last Saturday in the months of December, March, June, and September; and, consequently, will not exactly correspond with the quarters of the Registrar General. The extent and intensity of the more ordinary epidemics will be first considered in the same manner as in the "Summary" recently appended to the Weekly Returns; and, secondly, a few remarks will be offered on the Quarterly Mortality Tables of Mr. Royston.

Diseases.

As regards diseases, then, we are fully justified in asserting that the quarter just ended exhibits a highly unsatisfactory state of the public health. Both the total number of new cases of disease, and especially those of the zymotic order,—Scarlet Fever, Small-pox, Measles, Whooping Cough, and Continued Fever, alike appear very much in excess of the extent to which they prevailed in the year 1862. Thus, while the total number of cases amounted in the quarter ending September, 1862, to 16,334, during the late quarter it reached the more formidable total of 20,650, exhibiting an excess in the aggregate of about one fifth. In the same manner, as respects particular diseases, we may remark that in the September quarter of 1862 only fifty-eight cases of Scarlet Fever occurred, while in that just ended the number rose to six hundred and two. So, in the case of Small-pox, in 1862 we find thirty-eight cases,—in 1863 two hundred and sixty. Under Continued Fever, Measles, and Whooping Cough, we notice an increase amounting respectively to sixty-four, twenty-five, and sixty-seven. Diarrhœa, likewise, during the last three months, proved much more prevalent, the number of seizures in 1862 being 1,395, and in 1863 2,075.

Among the diseases of the late quarter two, especially, of the zymotic order, both from their general importance and from the extent to which they prevailed, demand consideration at our hands. And, first, as respects Small-pox: In the September quarter of 1861 only fourteen new cases occurred in connection with the Public Institutions of Manchester and Salford. During the corresponding quarter of 1862 the number rose to thirty-eight. From that time to the 6th of June of the present year the disease appears to have steadily gained ground. Thus, in the last quarter of 1862, no less than ninety-two cases were stated to have occurred; by the end of March the number amounted to three hundred and ten; and, by the end of June, in the second quarter of the present year, to five hundred and fifty-two. From this time, doubtless owing in no small degree to the attention directed to vaccination, and the removal of the sick from the abodes of the healthy to such Public Institutions as the Infirmary and Workhouse, the disease seems gradually to have abated. Thus, it is gratifying to be able to record in the last quarter a fall from five hundred and fifty-two cases to two hundred and sixty-three. If we now turn to consider the districts in which, during the last twelve months, the disease proved most prevalent, we obtain the following results: In the St. George's Poor Law District the number of cases was ninety-one; in the St. Peter's, seventy; in the St. Michael's, sixty-eight; and, in the St. Andrew's, sixty-three. One hundred and forty-two patients were admitted into the Workhouse and eighty more into the Infirmary. In the Salford Workhouse thirty-one cases were treated. As regards Salford we may observe that the disease proved later here in making its appearance than in Manchester. Thus, in the first quarter of the present year, one hundred and forty-nine cases occurred in the former and only twenty-one in the latter. In the following quarter, however, that terminating in June, we find the proportion relatively to population more nearly maintained, two hundred and seventy-four occurring in Manchester and one hundred and twenty-three in Salford.

Another point of much interest as respects the late epidemic of Small-pox concerns its *intensity*. Here, too, the Weekly Returns permit us to arrive at a tolerably correct

approximation to the truth. During the last twelve months, out of 1,126 persons attacked by the disease, forty-two are stated to have died. It is thus satisfactory to observe that though the late epidemic proved general it was by no means equally fatal, the death rate not exceeding one in 26·3. In fact it nearly exactly corresponded with that of Measles, which for the last year was one in 26.

Scarlet Fever. — Of the zymotic diseases prevailing during the late quarter by far the most general and fatal was Scarlet Fever. For a long time it has stealthily but progressively gained ground. Thus, in the September quarter of 1861, we find a record of only seventeen cases. In the corresponding quarter of the following year the number rose to fifty-eight. During the present year it has still more rapidly continued to increase. Thus, in the March quarter, one hundred and fifty-seven occurred; in that of June, two hundred and eighty-one; and in that just ended no less than six hundred and two. It is instructive to mark, both in the case of Small-pox and Scarlet Fever, a like tendency to spread gradually. The word "*outbreak*" then, as applied to these epidemics conveys an idea opposed to the truth. They do not fall *suddenly* on the population, like some destroying blight, but by little and little well nigh feel their way, as though courting the adoption of measures opposed to their spread. And if some such law of gradual diffusion is generally found to hold true in the case of epidemics, it would appear that, though certain states of the atmosphere doubtless prove peculiarly favourable to their spread, nevertheless in the great majority of seizures, at any rate, each particular case is literally passed on from man to man. This sort of gradual diffusion, as opposed to any sudden outbreak of the disease, is well seen by a reference to the numbers that occurred during each successive quarter in several of the Institutions and Districts. Thus, in the Poor Law Districts, the numbers for the last three quarters were sixty, ninety-six, and one hundred and fifty-nine. In the Manchester Public Institutions fifty-one, eighty-six, and one hundred and fifty-nine. In Salford fourteen, twenty-two, and thirty-nine. In Hulme six, twenty, and eighty-nine. In Chorlton fifteen, thirty-three, and one hundred and twenty-five; and, of course, similarly in respect to the general total of three quarters, one hundred and fifty-seven, two hundred and eighty-one, and six hundred and two.

Let us here turn to enquire what has been the *intensity* of the disease, in other words in what proportion relatively to the number attacked it proved fatal; and this enquiry is the more important from the meagre body of statistics bearing on this subject. We have already stated that, during the last three months, six hundred and two seizures are shown to have occurred; of this number seventy-three terminated fatally, exhibiting a death-rate of one in 8·3; and this proportion of deaths to cases appears in respect to Scarlet Fever to have been tolerably evenly maintained in each quarter in the course of the present epidemic, at least as concerns the general total of all the Institutions and Districts; though, on descending to particular localities, the range between the extremes proves very much wider. Thus, turning to the general Scarlet Fever death-rate, in each of the last four quarters, we find it in December 1 in 7·5, in March 1 in 7·9, in June 1 in 9·3, and last quarter, as already stated, 1 in 8·3. On looking to Districts, however, we find the highest death-rate in Ardwick (1 in 4·5), next among the patients of the Salford Dispensary (1 in 5·3), then follow Chorlton (1 in 5·5), Hulme (1 in 9·9), the Public Institutions

of Manchester (1 in 10·6), and, lastly, the Manchester Poor Law Districts (1 in 13·9).

The disease which exhibited the highest death-rate during the quarter was Diphtheria. But the number of cases was remarkably small, only nine; of these five ended in death, or 1 in 1·8. On taking a greater number of cases we still find the mortality very high. Thus, out of forty-five that occurred during the last twelve months, no fewer than fourteen died, or 1 in 3·2. We may observe that a strong proof of an essential distinction existing between Scarlet Fever and Diphtheria—a distinction by no means universally admitted—is the fact that, during the late extreme prevalence of the former, so few instances of the latter should have been found to occur.

Next to Diphtheria the most fatal disease of the year was Croup, the death-rate amounting to 1 in 2·5, then Scarlet Fever (1 in 8·3), Consumption (1 in 10·2), Inflammation of the Lungs and Pleurisy (1 in 10·6), Small-pox, Measles, and Continued Fever (1 in 26), Diarrhœa (1 in 30), Whooping Cough (1 in 32), and Bronchitis (1 in 40).

From the low death-rate under Continued Fever it is evident that the proportion of cases that belonged to the Typhus and Typhoid varieties of the disease was very small, probably not more than 1 in 5 or 6, the remainder being merely examples of Febricula, rarely observed to terminate in death.

Deaths.

The conclusions respecting the highly unsatisfactory state of the public health, at which we have arrived from an examination of the Weekly Returns, is fully borne out by the statistics contained in the last Quarterly Mortality Tables, drawn up for the Association by Mr. William Royston and appended to our Report. We would direct especial attention to the valuable information it contains. He there shows that in the course of the last three months the gain to every 10,000 of the population amounted from births to ninety-three; and the loss by deaths to eighty-one. Were such a birth and death rate maintained for twelve months the former would be represented by 39·5 in the thousand, and the latter by 32·4; the births only exceeding the deaths by about one-ninth. This low rate of increase has of late been frequently pointed out in the weekly "Summary." It contrasts unfavourably with the years 1861 and 1862, inasmuch as in each of those two years the death-rate amounted to 28, and the birth-rate to 39·5 and 39 respectively. It is right however to state that, during the first two quarters of the present year, the death-rate was lower than during the last three months; although, even then, it was at the rate of 30 to the thousand, or two more than in the years 1861 and 1862. On turning to particular districts we find that, in the quarter just terminated, the rate of mortality proved highest in Salford, where, out of every ten thousand persons living, 87 died; thus giving an annual death-rate of 34 in the thousand; but the births (103) were also unusually numerous. Thus the loss to the community was less marked here than in some other districts; in the Ancoats, London Road, and Deansgate, for example, 82 died in every 10,000, while the births to the same number of persons amounted to 87 and 88 respectively. In other words, in these Registration Districts, containing an aggregate population of upwards of 113,000, the number of deaths amounted to 938 and the births to 998, or an annual death-rate of 32·8 in the thousand, and a birth-rate of about 35. From none of the other districts are the returns so unsatisfactory. In Hulme a mortality of 81 occurred in the same number

of persons, in St. George's 78, in Ardwick, 75, in Chorlton 60, and, lastly, in Pendleton and Pendlebury 59.

Now, it may be asked, what are the causes to which this unsatisfactory state of the public health, as indicated both by the weekly disease tables and the mortality returns, is to be attributed? Is it simply due to that oft accused but somewhat vague expression—an unhealthy season? in other words to some obscure atmospheric influences opposed to health and longevity. To some extent, no doubt, such a season prevailed during the last quarter; week after week the Registrar General showed that the deaths in London exceeded the average. The excess, however, relatively to population in the case of the metropolis, proved considerably less than that exhibited in our returns. It seems difficult, then, to resist the conclusion that the hard times through which the people have passed and are still passing are beginning to tell; that a population long accustomed to live well on high but hard earned wages will not flourish beyond a certain time, at any rate in full physical vigour, under the various depressing influences which have combined to assail them. And what are these influences?—poor fare, mental depression, crowded dwellings, and a sickly season. That the food upon which the poorer portion of the factory operatives have been forced to subsist was not such as they were brought up on and accustomed to none will deny. It seems reasonable, likewise, to suppose that inability to obtain full employment among a population little disposed to shirk the calls of labour, by depressing the spirits, has a tendency also to lower the health. As a natural consequence of low wages houses and lodgings have been more densely occupied, and the never excessive supply of fresh air in the dwellings of the poor has been still more vitiated. In the first half of the present quarter the sun shone bright, penetrating even the smoky atmosphere of crowded cities. Decomposition proceeded more rapidly, the air heated even amid courts and alleys drew forth from the drains, no longer purified by copious showers, their noxious exhalations. In such warm weather as prevailed in July surprize must often have been felt, on observing that the mean temperature of the week was below the average for the season. We must bear in mind, however, that the mean reading of the thermometer is taken in the shade, while men in fulfilling their various avocations are often forced to endure the full rays of the sun. Thus their sensations and the reading of instruments, inasmuch as arrived at under different conditions, were not likely to tally. It is also on the brightest days that the range of temperature between night and day is often most marked; clear, cloudless nights permit the radiation of heat from the earth. At such times, then, it often happens that as the days are hotter so are the nights colder. That a chill often strikes in upon the system from such sudden transitions, especially trying during the period of infancy, may readily be believed.

Such, probably, were some of the causes which combined to render the third quarter of the year 1863, in these districts, so prolific in death and disease.

JOHN ED. MORGAN, M.B., M.A. (Oxon.),
HON. SECRETARY MANCHESTER AND SALFORD SANITARY ASSOCIATION.

Committee Rooms,
33, *Pall Mall.*

Powlson & Sons, Printers, Bow Street, John Dalton Street.

MANCHESTER AND SALFORD SANITARY ASSOCIATION.

MORTALITY RETURN FOR QUARTER ENDING SEPTEMBER 26th, 1863.

DISTRICT.	POPULATION, 1863.	SMALL-POX.		MEASLES.		WHOOPING-COUGH.		SCARLATINA.		DIARRHŒA.		FEVER.		DISEASE OF LUNGS.		ALL CAUSES.		BIRTHS.	
		No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.
Ancoats	56,191	5	·9	6	1·	12	2·1	48	8·6	95	17	11	2·	95	17	459	82	487	87
St. George's	48,294	6	1·25	15	3·12	20	4·17	30	6·25	76	16	6	1·25	61	13	375	78	455	95
Market Street (1861)	23,523	5	—	2	—	12	—	5	—	30	—	7	—	8	—	332	—	192	—
London Road and Deansgate	57,633	7	1·2	20	3·45	8	1·38	91	15·7	122	21	4	·7	34	6	479	82	511	88
alford	71,258	13	1·83	21	3·	26	3·6	30	4·22	127	18	15	211	110	15	615	87	732	103
endleton, &c.	25,160	1	·4	14	5·6	—	—	17	6·8	22	8	2	·8	—	—	147	59	229	91
horlton	45,140	5	1·11	5	1·11	6	1·33	42	9·3	37	8	6	1·3	54	12	269	60	365	81
ulme, &c.	71,461	10	1·4	7	1·	9	1·25	100	14·	72	10	15	2·	101	14	578	81	702	98
rdwick	22,124	6	2·7	3	1·4	6	2·7	22	10	22	22	4	1·8	30	14	165	75	244	110
TOTAL	420,784	58	1·37	93	2·2	99	2·35	385	9·14	603	14	70	1·66	493	11	3,419	81	3,917	93

This Quarter is compiled from the Weekly Returns, and consequently will not correspond with the Registrar's Quarter. The Rate is for every 10,000 of the population.

MANCHESTER AND SALFORD

SANITARY ASSOCIATION.

REPORT

OF THE

HEALTH

OF

MANCHESTER AND SALFORD

FOR THE FOURTH QUARTER OF THE YEAR 1863.

Compiled from the Weekly Returns of the Sanitary Association, and presented to the Committee.

MANCHESTER:
POWLSON & SONS, PRINTERS, BOW STREET, JOHN DALTON STREET.
1864.

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QUARTERLY REPORT.

In the fourth quarter of the year 1863 the state of the public health in Manchester and Salford, though more favorable than in the corresponding quarter of 1862, still proved less satisfactory than might have been desired. We learn from an examination of the weekly returns of the Sanitary Association that, in the last thirteen weeks of the year 1863, the total number of new cases of disease that came under the observation of the medical officers connected with our various Charitable Institutions and Poor Law Unions amounted to 21,131. In the corresponding quarter of the year 1862 it was 21,545; and, in the preceding September quarter, 20,650. On comparing the December quarters in the two years we obtain the following results:—The zymotic diseases, with the single exception of Measles, all proved more general in 1863 than in 1862, the Scarlet Fever cases amounting respectively in the two quarters to 867 and 172, those of Small-pox to 144 and 94, Fever to 734 and 703, Whooping Cough to 215 and 183, and, lastly, Measles to 121 and 236. On the other hand, Bronchitis and kindred affections of the chest, doubtless as a consequence of the intense cold which prevailed in the latter part of November, 1862, were far more general in that quarter than in the last thirteen weeks of the year 1863, the seizures amounting in the former to 4,797, in the latter to 3,533. It is worthy of remark that, though in the year 1862 so many persons experienced attacks of Bronchitis, Influenza, and Catarrh, still no corresponding increase was observed in respect to Consumption, which proved, if anything, somewhat more general in 1863.

Let us next turn to enquire what was the *intensity* of some of the more severe maladies, in other words what was the proportion of deaths to seizures. The disease which in the late quarter proved most fatal was Croup, one death occurring in every 2·6 cases; next follows Diphtheria, one in 3·6; Scarlet Fever, one in 6·3; Consumption, one in 9·6; Small-pox, one in 14·5; Measles, one in 15·1; Continued Fever, one in 26·2; and Bronchitis, one in 38. Of the 21,131 cases treated at the various Institutions and Poor Law Districts 639, or one in every 33, terminated in death. Of these deaths 123 arose from Scarlet Fever, 91 from Bronchitis, 80 from Consumption, 28 from Continued Fever, 13 from Small-pox, 10 from Diarrhœa, and 8 from Measles.

At the end of this Report will be found two most valuable Mortality Tables, drawn up for the Association by Mr. William Royston, the one representing the deaths in the course of the late quarter, the other during the whole of the year. In these tables Mr. Royston has calculated not only the total number of deaths and births in the several districts, but has likewise shown the rate to every 10,000 in which the more important diseases proved fatal. We learn in the former that, during the last

thirteen weeks of 1863, out of every 10,000 of the population 78 died, thus giving an annual death-rate of 31·2 to the 1,000. An examination of these tables clearly shows that the high quarterly mortality arose solely and exclusively from Scarlet Fever, for, on subtracting the deaths from this disorder from the general total, we find the death-toll reduced from 31 to 27 in the 1,000. In Mr. Royston's yearly table we learn that the deaths for the four quarters of the year 1863 amounted to 13,058, or about 31 per 1,000. That such a death-rate is high we are doubtless bound to admit, it is nevertheless important to bear in mind that the past year, generally, throughout the country, was an unhealthy one; and, if we compare the mortality of Manchester with that of Liverpool, we shall see grounds for feeling thankful that it did not prove still heavier. Thus, for the whole borough of Liverpool with its population of 443,930, the death-rate amounted to 33 per 1,000; in Manchester and Salford it was as we have observed 31. Again, in the parish of Liverpool, the most unhealthy quarter of the borough, it was 36·3; in Ancoats, a district occupying last year the same unenviable position in the mortality returns of Manchester, it was 34, or nearly 3 less. There is one circumstance, however, which renders the comparison between the two towns even more favorable to Manchester than the foregoing figures, standing alone, would lead us to infer — the wide-spread diffusion and fatality of Scarlet Fever. Such was not the case, at least to any corresponding degree, in Liverpool, for the report declares that "the stream of deaths was fed by every class of disease, and owed its dimensions to no single supply." This comparison between the mortality of the two chief towns of Lancashire, similarly situated in many important particulars, yet differing widely in the nature of the employment of a large portion of their population, goes to prove that, though among ourselves many of the operatives were by no means fully employed, nevertheless the public health has not in consequence suffered any material deterioration.

There is one question connected with the Manchester death-rate deserving the most serious consideration of the Sanitary Association, — that question concerns the excessive infantile mortality. With that courtesy and readiness to lend a helping hand which has ever characterized the various contributors to our Returns, the Registrars have this year favoured us with a statement of the number of deaths of children, under five years of age, which occurred last quarter in their respective districts. The results thus brought to light are certainly startling, for of the 3,286 deaths in the December quarter 1,622, or nearly one half, were those of children who had not yet completed their fifth year. In some of the districts even this heavy mortality was considerably exceeded: thus, in the Greengate district, it was at the rate of 58 per cent. of the total number of deaths; in the Ardwick of 56; in the Hulme of 54: in the Pendleton of 53; and in the Ancoats and Deansgate of 52. In the early deaths of these 1,622 children we read the grand explanation of that excessive mortality which has so often been brought forward against the inhabitants of the North-western division of England, as though the nature of the employment carried on in the cotton mills were necessarily inimical to health and longevity. That such is not the fact is rendered apparent by the following considerations: We have already stated that, during the last quarter, the deaths were at the rate of 31 in the 1,000, but of these 31 no fewer than 15 were in children under five years of age. Now it was shown by Mr. Royston nearly four years ago, that in some healthy country district as, for example,

in Glendale in Cumberland, the death-rate at this early age does not exceed four in the 1,000; could then the mortality in Manchester be reduced within equally narrow limits the annual death-toll would be represented by 20, instead of 31. The average for the whole county is 22.

Having thus touched, generally, on some of the more important diseases which prevailed during the last quarter, having pointed out both the number of deaths and the early age at which many of those deaths occurred, we propose, briefly to consider some points of interest as regards the mode of diffusion and history of that disorder which contributed in so marked a degree to swell the tide both of death and disease. First, then, the statistics of the last quarter tend still further to confirm a remark made in our last Report, that the advance of Scarlet Fever is in all cases steady and progressive, not sudden or rapid. It does not burst out in different quarters of the town at one and the same time, as though propagated by some obscure but widely diffused epidemic influence, on the contrary it appears to travel from district to district, and during each successive quarter, and well-nigh during every passing week, steadily gathers strength. Thus, the first week in which in the course of the present epidemic it appeared to any unusual extent, was that terminating September 13th, 1862; in that return were recorded 11 new cases, 6 of them in a single district: in the first quarter of the following year the number amounted to 157. The disease at that time was principally confined to the township of Manchester; in Salford and Hulme the seizures were only 14 and 6. In the next quarter 281 patients applied for relief; in the third 602; and, in the fourth and last, 867. It is important, moreover, to bear in mind that these figures refer only to those persons who presented themselves at our Public Charitable Institutions, and probably did not constitute more than about one seventh of the cases which actually occurred. On turning to particular districts the same law of gradual diffusion becomes still more strikingly apparent. Thus, in St. Peter's District, the respective number of Scarlet Fever seizures in each of the four last quarters were 5, 14, 18, and 36; in St. Andrew's, 10, 12, 26, and 46; in St. Jude's, 7, 24, 28, and 38; in District I. of the Royal Infirmary, 9, 9, 16, and 18; in District II., 10, 17, 21, and 31; in District III., 13, 19, 40, and 66; at the Salford Dispensary, 11, 17, 32, and 88; and so on in almost all the remaining quarters of the town. We observe, in fact, at first but a few scattered cases which, as months and quarters roll on, become more and more widely disseminated.

There is another question connected with Scarlet Fever on which the statistics of the Sanitary Association help to throw some light, — it bears on the opinion held by many zealous though probably too enthusiastic sanitary reformers which would, if established, go to prove that both Scarlet Fever, and indeed all the other zymotic diseases, are primarily and essentially generated by the exhalations emitted from decomposing animal and vegetable matter. Now, though it may be and probably is true that defective drainage tends, in some degree, to intensify many of these disorders, we have no grounds for believing that it ever proved the sole exciting cause of any single attack, either of Scarlet Fever or Small-pox. Indeed there are many districts in Manchester second to none either as regards the attention bestowed on the drainage or the purity of the water supply, and yet, even in such apparently favoured localities, the disorder has taken on a highly malignant form, and the proportion of deaths to seizures proved unusually high. Further, that mere organic decomposition is incapable of generating either this or

any of the other exanthematous fevers, we are, at least in some measure, warranted in inferring from the consideration that these disorders were altogether unknown in those ancient cities with the diseases of which, thanks to the admirable descriptions of their writers on medicine we are more intimately acquainted, and in which, owing to their notoriously defective sanitary conditions, the germs for their development, if such they really be, were most widely and lavishly disseminated.

A further interesting fact connected with Scarlet Fever is the character of greater malignancy it appears to assume in certain localities than in others, to all appearance at least, similarly situated, and it is here that we find the condition of the Manchester Poor Law Districts generally favorable. Taking them collectively we observe that in the course of the year 1863 the deaths to cases were only in the proportion of 1 to 13·5; ranging, however, from 1 in 31 in St. Michael's District, to 1 in 7 in St. Peter's; among the patients of the Royal Infirmary they were 1 in 9. In many other quarters of the town the Scarlet Fever death-rate was very much higher. Among the patients of the Salford Dispensary 1 in every 6·7 died; in St. George's, Hulme, 1 in every 5·8; in the Chorlton Poor Law District 1 in 5·7; among the patients of the Chorlton Dispensary 1 in 4·7; in the parish of St. Philip's, Hulme, 1 in 4·2; and, at the Ardwick and Ancoats Dispensary, out of 76 cases, no fewer than 24, or 1 in 3·1 terminated fatally.

Another point of interest in the present visitation of Scarlet Fever concerns the progressively increasing intensity, the proportion of deaths to seizures having steadily risen. Thus, in the second quarter of last year, only 1 case in every 9·3 proved fatal; in the third, 1 in 8·3; and, in the fourth, 1 in 6·3. This increase is very considerable, amounting in fact to nearly three deaths instead of two to every twenty seizures.

In the foregoing remarks we have endeavoured to show that, whatever were the sources from which Scarlet Fever first originated, at present at any rate actual contagion, either by intercourse with those affected, or through the medium of fornites, proves its great exciting cause. Secondly, that an examination of the statistics of the Sanitary Association lends no colour to the assertion that the disease is capable of being spontaneously generated. Thirdly, that in certain quarters of the town, for some reason not readily explained, though not necessarily less generally diffused, it nevertheless assumes a milder type. Fourthly, that its advance in the course of the present epidemic has been characterized by an increase also in its fatality.

Now, if the conclusions at which we have arrived be correct, it is proper that we should consider, inasmuch as the disorder is even now raging, what steps can be taken by the Sanitary Association with the view of setting some barrier to its onward march. And here let us recal to mind the course of action adopted some twelve months ago when a similar danger impended from Small Pox. At that time the Sanitary Association not only called upon the authorities to use their best efforts in enforcing the removal of the sick from the abodes of the healthy, but also, through the public press, made known the reality of the peril and the best method of checking its encroachments. As a consequence of the timely warning thus raised no fewer than 331 patients were removed to the Public Workhouses, Fever Wards; and, inasmuch as the total number of seizures in the course of the year did not exceed 1,269, 1 in every 3·8 cases were separated from their relatives, and thus prevented

from becoming so many fresh centres of infection. When, however, we turn to enquire how far this attention to the isolation of affected persons has been observed in respect to Scarlet Fever, we find that in the course of the year only 28 out of 1,927 patients were removed to the Workhouses and Fever Hospital. To the encouraging such separation of the sick the Sanitary Association will doubtless direct its best efforts. The object may probably be promoted by addressing the Boards of Guardians on the subject; and, likewise, by pointing out to the managers of Schools and of Mills the great danger attending the admission of children from houses in which the disorder is known to prevail, and by not permitting the convalescent to return to their work for some weeks subsequently to their recovery. Such precautions, at the present day, are constantly observed in the better regulated Schools throughout the country, and, considering the heavy issue at stake, the hardship of enforcing them on the poor would not be oppressive. These remarks naturally apply solely to the poorer portion of the population, those in fact who are dependant on charity for their treatment in sickness. But the question arises as to whether, when epidemics are raging, it might not be expedient to encourage the establishment in various quarters of the town of self-supporting institutions in which, on the payment of a weekly fee, the children of artisans and of such persons among the middle classes as might desire to avail themselves of their benefits might obtain admission. Such institutions should be situated in those quarters of the town in which the disease was observed to take on a mild type. By such an arrangement those dwelling in localities less favorable to the disorder would, by the circumstance of removal alone, reap advantage. In many cases, also, in which at present every member of a family is successively attacked, the immediate removal of the first seizure might arrest the disease at its source. Such are some of the questions which a careful examination of the statistics of the Sanitary Association for the last quarter of the year 1863 have appeared to suggest,—for the investigation of others probably no less important they supply a rich store of materials; to some of them we hope in our future reports to revert, but at present the long-continued severity of a ruthless epidemic especially singled it out as one in respect to which popular fallacies however deeply rooted should be removed, the laws which govern its diffusion pointed out, and the conclusions they teach applied to check its increasing extension.

JOHN ED. MORGAN, M.B., M.A., Oxon.,

Hon. Sec. of the Sanitary Association.

MANCHESTER AND SALFORD SANITARY ASSOCIATION.

MORTALITY RETURN FOR QUARTER ENDING DECEMBER, 1863.

DISTRICTS.	POPULATION, 1863.	SMALL-POX.		MEASLES.		WHOOPING-COUGH.		SCARLATINA.		DIARRHŒA.		FEVER.		DISEASE OF LUNGS.		ALL CAUSES.		BIRTHS.		EXCESS OF BIRTHS OVER DEATHS.	
		No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.
MANCHESTER. Ancoats	56,191	2	·35	1	·17	10	1·78	113	20	16	2·86	13	2·32	148	26	489	88	509	91	20	—
MANCHESTER. St. George's	48,294	—	—	3	·62	20	4·16	41	8½	9	1·87	22	4·58	110	23	370	77	442	92	72	—
MANCHESTER. Market-street, 1861	23,523	3	—	—	—	4	—	21	—	7	—	26	—	13	—	315	—	220	—	95	—
MANCHESTER. London-road and Deansgate	57,633	2	·36	3	·52	6	1·05	91	16·	28	5·	11	1·91	53	9	454	79	485	84	31	—
Salford	71,258	5	·7	17	2·4	17	2·4	56	8·	25	3·52	15	2·11	138	19	515	72	727	102	212	—
Pendleton, &c.	25,160	1	·4	3	1·2	2	·8	20	8·	7	2·8	5	2·	2	·8	152	61	203	81	51	—
Chorlton	45,140	2	·44	3	·67	6	1·33	70	15·	7	1·55	8	1·8	75	17	291	64	368	81	77	—
Hulme, &c.	71,461	8	1·12	7	·98	12	1·68	118	16·	13	1·82	21	2·94	140	20	538	75	769	108	231	—
Ardwick	22,124	2	·91	1	·45	2	·91	31	14·	7	3·18	8	3·63	38	17	162	74	250	114	88	—
TOTAL	420,784	25	·6	38	·9	79	1·88	561	13	119	2·82	129	3·06	717	17	3,286	78	3,973	94	687	—

This Quarter is compiled from the Weekly Returns, and consequently will not correspond with the Registrar's Quarter. The Rate is for every 10,000 of the population.

MANCHESTER AND SALFORD SANITARY ASSOCIATION.

MORTALITY RETURN FOR YEAR ENDING 1863.

DISTRICTS.	Population, 1863.	Small-Pox.		Measles.		Whooping-Cough.		Scarlatina.		Diarrhœa.		Fever.		Disease of Lungs.		All Causes.		Births.		Excess of Births over Deaths.	
		No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No.	Rate.	No	Rate.	No.	Rate.	No.	Rate.
Manchester. Ancoats	56,191	29	5·18	59	10·53	52	9·3	279	50	129	23	49	8·75	561	100	1900	340	2172	388	272	48
Manchester. St. George's	48,294	25	5·21	41	8·54	53	11·	141	29	102	21	47	9·8	357	74	1433	298	1884	391	451	93
Manchester. Market-street, 1861	23,523	19	—	6	—	20	—	37	—	47	—	60	—	45	—	1332	—	899	—	433	—
Manchester. London-road and Deansgate	57,633	13	2·25	64	11·11	38	6·6	253	44	169	29	49	8·52	211	37	1849	321	2039	354	190	33
Salford	71,258	30	4·22	66	9·3	87	12·25	122	17	189	27	60	8·45	538	76	2119	298	2961	417	842	119
Pendleton, &c.	25,160	5	2·	26	10·4	6	2·4	48	19	33	13	20	8·	2	·8	584	234	956	382	372	148
Chorlton	45,140	10	2·22	24	5·33	29	6·44	151	33	49	11	28	6·22	310	69	1100	244	1510	335	410	91
Hulme, &c.	71,461	24	3·36	48	6·72	57	8·	263	37	91	13	57	8·	552	77	2068	288	3062	428	994	140
Ardwick	22,124	11	5·	27	12·28	13	6·	81	37	39	18	29	13·	173	80	673	306	1016	462	343	156
Total	420,784	166	3·94	361	8·58	355	8·44	1375	33	848	21	399	9·5	2749	65	13058	310	16499	392	3441	82

This Year is compiled from the Weekly Returns, and consequently will not correspond with the Registrar's Year. The Rate is for every 10,000 of the population.

VENTILATION

BY MEANS OF

THE PATENT

PNEUMATIC OR AIR-SYPHON,

WITH OR WITHOUT ARTIFICIAL HEAT.

THE process does not require a fire, or any other artificial heat, or moving power. It consists of the practical application of operations constantly taking effect in the atmosphere, which cause a current to take place through an inverted syphon, having one of its branches considerably longer than the other (whether it be in the open air or with the shorter branch communicating with a room or other place), into which the air enters at the orifice of the short branch, and is discharged by that of the longer. This process is not prevented by making the short branch hotter than the long. When it is proposed, in the hereafter described arrangements, to use the chimney as the long branch, it is because of there being such a channel at hand, and because it is capable of serving a double purpose when the season requires fire, and is conveniently available for the single purpose (ventilation) when fire is *not* required.

Ventilation by means of the Air-syphon has for its objects the removal of heated and of all impure air that has become diffused through an apartment; the removal of hot and impure air, produced by the combustion of gas, &c., *prior* to its being diffused; the prevention of accidents from the escape of gas in apartments thus ventilated; and the removal of impure air from vaults and cellars; and from all places requiring ventilation.*

The means of carrying these objects into effect are the adaptation of a way or channel, or ways or channels, to the agency of the natural operations referred to.

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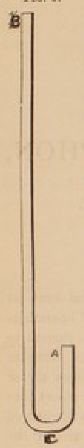
* The prevention of accident from the accumulation of gas in the goaves, and other confined parts or apartments of mines.

FIG. 1.



A syphon-shaped tube, having one of its branches longer than the other, represents the way, or channel—the short branch A (Fig. 1,) constituting the channel of entrance, and the long, B, that of exit, C the intermediate branch. There may be two or more short or receiving branches, and they may enter the long branch separately, or unite, and enter by a common channel.

The syphon exercises a demand upon the apartment for air; the demand is greater in proportion to the excess of altitude of the long branch over that of the short. FREE ADMISSION of pure air is necessary, as in all other systems of ventilation. The success of the air-syphon would be defeated by the absence of a supply to the demand which it exercises.

External air is preferable to air from the passages. It should not pass behind skirting-boards, under floors, or within partitions of lath and plaster, *except* in tubes. The place of ingress might be any part of the room, where it would be least inconvenient to the occupiers; it is not necessary that it should be at the lower part of the room; that it should enter by small orifices, apart from each other, is preferable to its entering by one large orifice.

The advantages afforded by the pneumatic syphon, like those afforded by the hydraulic syphon, are, that it gives a command over currents, which enables us not only to conduct them in horizontal directions, but to occasion their taking place in courses apparently contrary to their natural tendencies; the heavy liquid water, for example, *rising* in the former, *apparently* in opposition to laws by which its weight should oblige it to fall, and light air descending in the latter, *apparently* in contradiction of laws which should oblige it to rise.

In the event of its being necessary for the removal of impure air, that it should be made to descend from the upper parts of an apartment, whether a vault, or a cellar, or inhabited room, or other place, down to the floor, or under the floor, and to pass under or through a partition or wall into the flue of another apartment, or into a flue on the outside of the building,* the pneumatic syphon supplies the means of so causing it to descend, and of its being so conducted away.

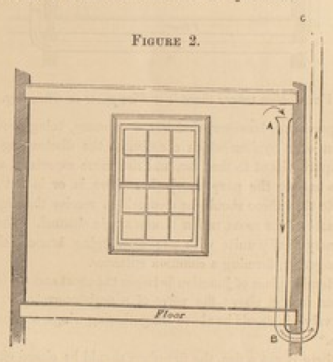
* Although the short branch may in some instances be carried with a successful result into the chimney of another apartment having a fire in it, yet there is always risk of its failing, owing to the complication of influences which come into operation, unless those influences are taken into consideration and provided against.

One of the peculiarities which may be enumerated amongst the advantages of the system is, that in proportion as the scale (that is to say, the magnitude of the apparatus) is increased, so does its acting power increase.*

Ventilation where there is no Fire-place or Chimney.

Figure 2 represents a room (in the lower or lowest part of a house, as the basement, for example) without a fire-place, and a syphon, of which the short branch, A, descends from near the ceiling, down to and through the floor; the bend, or connecting portion, B, passes through the external wall, and the long branch, C, ascends in the open air above the top of the house or building. A channel so placed will keep up a constant change of the air admitted into the apartment.

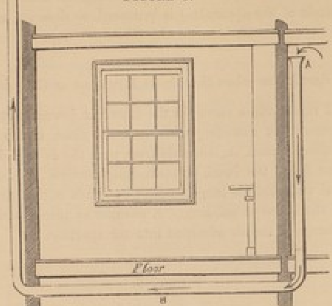
FIGURE 2.



That portion of the syphon, B, which connects the short and the long branches, A and C, might be carried under the floor of a second room (or rooms), as represented in Figure 3, (page 4); thus, the most central room, or closet, or compartment of any kind in a building might be made to be in direct communication with the external air.

* Mr. Burn, in his very useful work, replete with practical remarks on ventilation, says, with reference to the *air-syphon ventilation*, after having experimented satisfactorily with a tube on a small scale—"If acting with certainty on a large scale, we hail the invention as one of the most important of the day; so simple in its nature, so easy in its application, it really is a boon to the community."

FIGURE 3.



Ventilation where there is a Fire-place or Chimney.

Every apartment, however, that has a chimney, being provided with that portion of a syphon which constitutes the discharging branch, it might be appropriated to that use, and the more especially, as it might be made to answer the purpose whether there is or is not a fire. It is preferable that there should be channels to receive the impure air at different parts of the room, rather than a single channel. The receiving branches may finally unite with the discharging branch, either separately or together, forming a common entrance.

The preferable place of junction between the short and the long branch or branches is just above the valve of a register-grate, or, in the absence of a valve, it should be above the gathering wings, and in the throat of the flue.*

When there is not a fire, the fire-place should be closed either by the valve, or other convenient means, or by a chimney-board. When by the latter, the place of junction might be through the chimney-board, and at any part, however low.

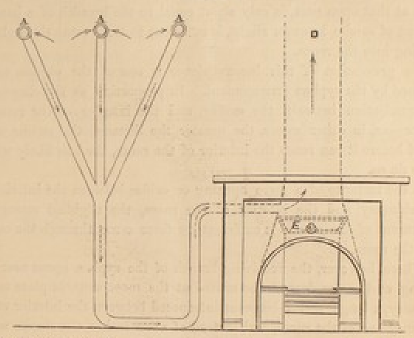
The register-stove, or any other grate having a valve, is preferable to

* A great advantage arising from the junction being at this point, instead of at a greater height, is, that the heat causes the current of air making its exit from the receiving branch to be more rapid, and by consequence the entrance of air into it to be more rapid, occasioning, in a given time, a larger removal of impure air from the upper part of the room.

a grate which has not. A suitable valve, however, might be put into any chimney.*

Assuming that the Figure 4 represents a grate with the valve closed below the place of junction, between the receiving branches A A A, and the discharging branch D, they together form a continuous channel or syphon.

FIGURE 4.



Chimneys having down-draughts, or subject to gusts of wind blowing down them, are not favourable to ventilation, either by the air-syphon, or by any other method, in which the chimney is to be the channel of exit.

It is *necessary* to distinguish between down-draughts and *down-blowing gusts.*

The cause of down-draughts is deficient supply of external air to the interior of the house, or to the individual apartment. They are more common at night, when the windows, window-shutters, doors, &c., &c., being shut, the usual inlets of external air are closed. Air should be supplied to the house through pure channels or apertures; as, otherwise, it descends through the chimneys, bringing impure smells, &c., with it.

Chimneys liable to down-blowing gusts are those adjacent to chimneys or chimney-pots higher than themselves, or in the vicinity of lofty buildings, trees, &c., &c. The best remedies are adding height to the chimney, or a wind-guard.

* A valve so introduced should not have the area of the valve greater than that of the smallest part of the smoke-flue, or of the exit at the top.

Although it is only in certain chimneys that these gusts drive the smoke so low as to make it visible at the fire-place, yet few are wholly free from occasional slight checks. The irregular movements of the wind at all times, produce eddies and evolutions sufficient to cause such checks, which, however, are comparatively momentary, and the smoke at once resumes its course. When, however, there is an opening into the chimney, and the distance between the smoke and the interior of the room at that open part, is only about equal to the breadth of a hand, a descent of smoke, however slight, is sufficient to force some through the opening into the room.

The prevention of this inconvenience is one of the objects to be attained by the syphon arrangement. In proportion as the channel of communication between the smoke, and the interior of the room is longer—or, in other words, the greater the distance the smoke must travel before it can reach the interior of the room, the less likely will it be to do so.

In the instance of a mere opening or orifice between the interior of the chimney and the interior of the room, the slightest retrograde movement of the smoke is sufficient to force some through the orifice into the room.

Where, however, the receiving branch of the syphon opens near the ceiling, and passes down to be united at the most suitable place to the chimney, a long distance becomes interposed between the interior of the chimney and of the room, and, instead of a few inches, the smoke would be obliged to traverse many feet before it could escape. Thus, the light and transitory checks given to the progress of the smoke, which, where the distance is short, force smoke into the room, have no effect of the kind where a long channel has first to be traversed.

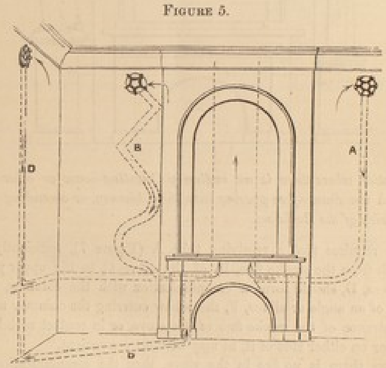
Indeed, even in the event of strong gusts, still the smoke, before it could escape into the room through the channel forming the receiving branch of the syphon, must force its way into the room at the opening of the fire-place itself—that being the nearer and readier place of escape. Thus, even in extreme cases, where down-blowing gusts actually force the smoke into the room at the fire-place, it is not forced through the channel appropriated to ventilation.

Buildings and Alterations.

It is scarcely necessary to say, that houses in progress of building, or of undergoing repairs, afford the best opportunities of providing for ventilation—that is to say, for the free *admission* of pure air by proper

channels and at proper parts, and for the egress of the air that has become impure. That free admission of air is indispensable, has been already said; as, also, that although a chimney and fire-place are not necessary, yet, there being a chimney available, it may be used. Assuming it to be so used, a hollow channel or channels, having their receiving orifices at any required elevation, and at any part of the room, may be formed or chased in the brickwork, constituting receiving or short branches. These may be conducted to the point of junction with the chimney by leading them under the floor from one side of the room to another, as represented in Figure 5, D D. Those on the same side of the room as the fire-place may pass in any direction, as A, or have any angles or curves, as B. It may, however, be regarded as a rule, that the fewer its angles or curves, in passing to the long branch, the friction and obstructions being less, the ventilating power will be better preserved.

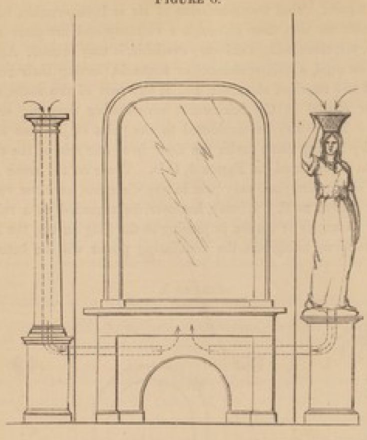
Figure 5.



Where it is preferable, or more convenient, the channels* may be in the interior of the room, either as columns or pilasters, or passing through ornamental figures, as represented in Figure 6, (page 8.)

* The channel constituting the short branch may be on the outside of the house where the chimney is in an outer wall, its lower extremity entering the chimney by being carried in through the brickwork to the proper place, just above the register valve of the stove, and its upper extremity entering the room through the brickwork at the required height; thus the receiving orifice *alone* being within the room.

FIGURE 6.



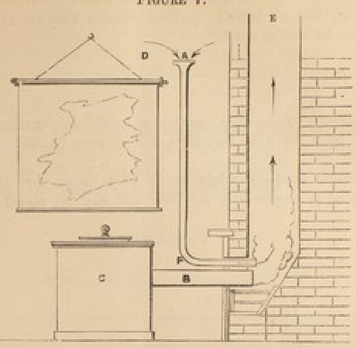
Ventilation where there is an ordinary Counting-house or other Stove, with the Smoke-flue passing into the Chimney, or ascending on the outside of the Building.

This requires that a receiving tube, A (Figure 7), sufficiently long to reach from the smoke flue, B, of the stove, C, to the upper part of the room, D, should form a communication with the chimney, E, by means of an angle or elbow, F, the elbow entering the chimney near to the entrance of the smoke flue of the stove, or in contact with it, and above or on either side of it, as may be most convenient.*

When there is no fire in the stove, then the communication with the chimney by the smoke-flue should be cut off by a damper, in order that the short branch, A, and long branch, E, may together constitute a continuous and unbroken channel or syphon.

* The receiving branch, A, might, if preferred, be carried down on the inside of the chimney, having its receiving orifice still opening by an elbow into the room, and its lower elbow in juxta-position with the termination of the smoke-flue of the stove within the chimney.

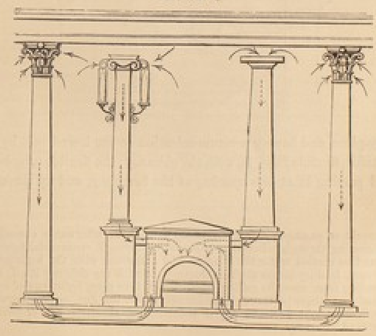
FIGURE 7.



Ventilation where there is a Fire-place with a Descending Flue into a Chimney.

These stoves, as represented in Figure 8, which perform so well their duty as grates in giving warmth, may have that of ventilating the

FIGURE 8.

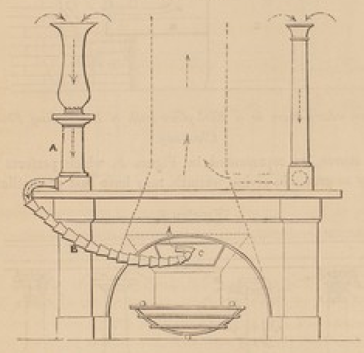


upper parts of the room superadded, a duty which, by suitable arrangements, they may be made to perform, whether they are at the time being used for fires or not.*

Ventilation for Temporary Purposes, as in Sick Rooms, Nurseries, or other Places, by Portable and Temporary Ventilators.

A portable ventilator might consist of a hollow channel or tube (represented in Figure 9 by the pillar and vase, A), placed upon the

FIGURE 9.



chimney-piece, and having a communication at the lowest part by means of a metallic, flexible tube, B, with the chimney; the flexible tube descending, and passing in at the opening of the fire-place, and up through the

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* Channels or passages, either originally formed, or afterwards chased in the walls, or passing through pilasters or columns, or through ornamental figures, may descend and be carried under the floor, and be connected with the horizontal flues under ground, leading to the shaft or chimney, or with the chimney itself; or channels extending from near the ceiling down to the stove may, by means of openings, pass laterally or otherwise through the ironwork into the flue, or be otherwise connected with the smoke-flue. To any of the receiving channels, gas or other lights may be affixed.

aperture in the register valve, C, into the chimney. The bend or elbow, left visible in the Figure, might be carried up into the opening of the valve, and the tube might be suspended by it. The elbow does not interfere with the free passage of the impure air into the chimney.*

A portable ventilator might be also placed on the floor, in the form of a pillar, or of any other form, having similar means of communication with the chimney.†

When there is a fire in the grate, then the adjustment described supplies all that is necessary, but when there is not, then a chimney-board should be used, and the tube of communication might be inserted through an opening left in it for that purpose.

Ventilation by means of Rout-Forms, &c.

The forms may themselves constitute channels, or metallic or other channels may be fixed under the seats, these being made to communicate with each other, and the nearest to the fire-place with the chimney, by a tube or tubes for that purpose. Upright tubes, as represented (Figure 11), communicating with the channels in the forms, might be carried to the higher parts of the room, at any convenient parts, to receive and carry away the heated and impure air. When there is a fire in the room, they should be carried up into the chimney above the

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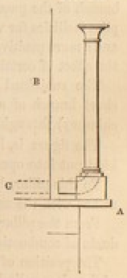
* Or an opening might be cut through the brickwork in the front of the chimney-breast, and fitted with a collar or socket, through which a communication with the chimney might be made by a portion of tube (to fit the collar), proceeding from the back part of the column represented in the diagram. An ornament might be made to fit the collar, so as both to close and to conceal the opening, should it be desired to remove the ventilator. Figure 10 represents a sectional view of such movable ventilator, with the tube of communication at the bottom of the pillar, and the collar fixed in the brickwork to receive it. A, the chimney-piece; B, the face of the chimney-breast; C, the collar in the brickwork.

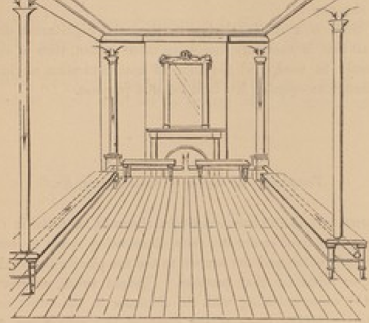
† The modes may be various. Stoves may be cast with special arrangements for ventilation, admitting of the ready application of the portable ventilator. Chimney-pieces may be formed with a view to the same object, &c. The form of the portable ventilator might be varied, so as to suit any particular place or occasion. The place of the flexible metallic tube might be supplied by common metallic tube when convenient, having the necessary angles and joints. The size of the tubes must be determined by the dimensions of the room.

FIG. 10.



register-valve; when there is not a fire, a chimney-board should be used, with apertures in it, to admit of the necessary communication.

FIGURE 11.



Gas and other Lights so arranged that their Heat and Smoke are not permitted to diffuse themselves into the Apartment, and that general Ventilation is at the same time accelerated.

The fact that heated and even hot air descends through the shorter branch of the pneumatic syphon, and is discharged by the longer, supplies facilities for ventilation which admit of almost universal application, and a more positive or more useful example can scarcely be given, than in the effect of certain adaptations in connexion with the burning of gas.

The subjoined figure (12) represents, in the form of a pillar, the short branch of a syphon communicating with the long branch (the chimney) through a chimney-board.

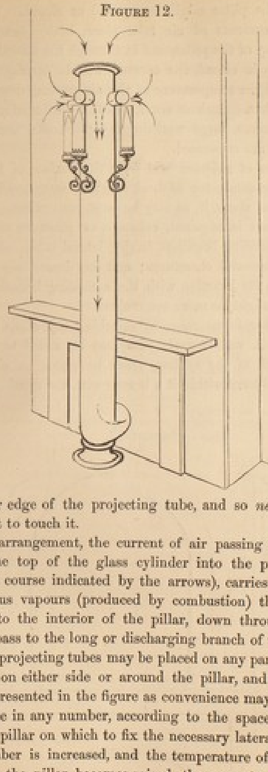
The figure is, however, a mere sketch of the first apparatus of the kind put into operation, in its crude state.

To this pillar, branches with Argand gas-burners are attached, furnished with the usual glass cylinder around each flame.

From the pillar, lateral tubes project horizontally, to receive the products of combustion as they escape from the top of the glass cylinder.

The position of each gas-burner is so arranged, that the upper edge of the glass cylinder, on that side nearest the pillar, shall be on a level

FIGURE 12.



with the lower edge of the projecting tube, and so *near* to its under edge as almost to touch it.

Under this arrangement, the current of air passing from the apartment, over the top of the glass cylinder into the projecting lateral branch (in the course indicated by the arrows), carries with it the heat and the noxious vapours (produced by combustion) through the projecting tubes to the interior of the pillar, down through which they descend, and pass to the long or discharging branch of the air-syphon.

The lateral projecting tubes may be placed on any part of the pillar—that is to say, on either side or around the pillar, and as much lower than those represented in the figure as convenience may require.

They may be in any number, according to the space afforded by the surface of the pillar on which to fix the necessary lateral tubes.

As the number is increased, and the temperature of the air passing down through the pillar becomes raised, the currents will be quicker, and the ventilating power exercised on the whole atmosphere of the apartment, as well as on the heat and vapour of each individual burner, will be stronger.

The top of the pillar might be opened or closed. When the top is opened, the currents of air take place, both down through the opening at the top of the pillar, and in through the lateral tubes.

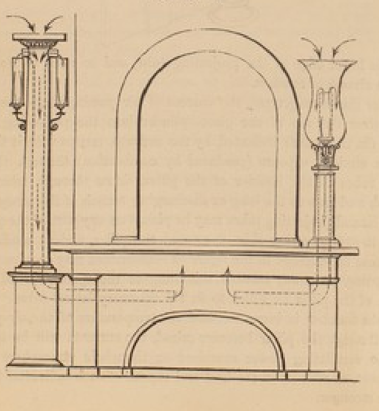
When the top is closed, the currents will be stronger through the lateral tubes, and the temperature of the air passing down through the pillar will be higher. Such an arrangement is particularly advantageous in shops, warehouses, large workshops, workrooms, &c., where large quantities of gas are consumed.

The advantages of radiated heat from the surface of the pillar may be had, or a non-conductor of heat might be employed to form the pillar, or be placed about it, as may be most convenient.

Where ornament is required, columns, or pilasters, or figures, may be made the descending branches, having lateral tubes, either visible or concealed in ornamental structures; and the descending branch might be made to form its junction with the ascending branch, or chimney, in any way that might be more convenient.

Burners of other forms may, by suitable adaptations, be used with similar results. A vase-shaped glass may be added to the short, or descending branch of the syphon, (thus becoming an elongation and portion of it,) and have within it a burner with the usual glass chimney.

Figure 13.



The necessary arrangements being made for supplying the burner with air, independently of the descending current, the heat and products of combustion descend with that current, and pass away.

By either of these arrangements, as represented above, with the lateral tubes on the one hand, or the vase-shaped glass on the other, not only are the products of combustion carried away, but the open orifices become ready and very *capacious* channels of active ventilation to the whole apartment.

NOTICES OF THE PRESS.

Literary Gazette, September 8th, 1849.—"*Important Discovery in Ventilation.*—The improvements are based on an action in the syphon. A more useful and important discovery has never been made, for the comfort and health of civilized man. We see no end to its application. There is not a sanatory measure suggested to which it may not form a most beneficial adjunct.—We have witnessed the experiments in various ways, with tubes from less than an inch to nearly a foot in diameter, and we can vouch for the fact being perfectly demonstrated. Light gas does descend the shorter leg when heated, and ascend the longer leg when the column of air is much colder."—Ed. *Lit. Gaz.*

Bell's Life in London, September 9th, 1849.—"*Free Ventilation.*—The *modus operandi* is on the principle of the syphon or bent tube—the new, or 'air-syphon'—by which this object may be most effectively secured. There is not the slightest ambiguity as to the principle of the action, or of complexity in the mechanical aids, required to give it full effect, and yet to see it in operation, it practically contradicts the commonly received notions of aerial circulation."

Lady's Newspaper, September 16th, 1849.—"Improvements in ventilating rooms and apartments, of the perfect efficacy of which we believe there cannot be a doubt—the improvements are based on an action in the syphon. It is easy to see how readily this can be applied to any chamber."

Illustrated London News, October 6th, 1849.—"*Patent Air-Syphon Ventilation.*—The advantage of every step in science, by which our knowledge is increased, even to the extent of one additional fact, is the almost certainty that it may be turned to useful account. A peculiar fact is, that this mode of ventilation affords facilities hitherto not known for carrying away the heat, and other products of combustion from gas burners, and other lamps of which the products are offensive. Again, wherever the 'air-syphon' ventilation is in operation, it is certain that should any accidental escape of gas take place, it will not accumulate, but descend from the upper part of the room by means of the syphon. The formation of the necessary channels appears to be compatible with the preservation of architectural ornaments. The applications of this important discovery will doubtless be very numerous."

Family Herald, October 6th, 1849.—"*New Mode of Ventilation, based upon the action of the Syphon.*—It is easy to see how readily this can be applied in a chamber, in order to purify its atmosphere."

Chambers' Edinburgh Journal, October 14th, 1839.—"A means of ventilating rooms and houses has just been patented, which promises great results. It is an application of the inverted syphon. If the instrument be generally available, we shall have obtained at last the long-desired possibility of breathing pure air within our habitations."

The Illustrated London Almanack for 1850.—"*Patent Air-Syphon Ventilation.*—The air-syphon ventilation admits also of being extemporaneously and temporarily set up in a sick room, so as to cause a constant removal of air from the upper portion of the apartment, where it is so apt to hang about the curtain furniture of the chamber, and to impregnate it with the exhalations, which are so often both the results, and generators of disease. This mode of ventilation affords facilities for carrying away the heat and other products of combustion."

Savill & Edwards, Printers, 4, Chandos-street.

COSTLESS VENTILATION.

From "the Builder," March 1st, April 19th, 1862.

A CONSTANT supply of fresh air is so important to our well-being, and in the prevention and cure of disease, that the subject needs no comment: an attendance, however, at any public meeting, is only necessary to convince how much this axiom is ignored,—or if admitted, how unsuccessfully met;—"crowded to suffocation" indeed, being the conventional term used to express a full assemblage.

For some time I recommended to my patients the plan of opening the window-sash at the top, and stretching out on a frame a corresponding depth of tarlatan, to intercept blacks and prevent draught; but, although a modification of, but not an improvement on, this method, has the support of a popular lecturer at an institution for the diffusion of art and science, the principle is wrong and the result unsatisfactory, as the draught is directed downwards on the sitter, and not upwards towards the ceiling; the screen, too, is anything but ornamental, and becomes clogged with blacks, so as to require removal and repair.

The method I now use is simple, economical, quite free from draught, and does not get out of order. Raise the lower sash of the window, and place in front of the opening at the bottom rail a piece of wood of any approved depth,—from two to three inches is sufficient: this leaves a corresponding space between the meeting rails in the middle of the window, through which the current of air is directed upwards towards the ceiling: heavy blacks cannot ascend with the air, which is driven so high as to be warmed before it descends; light blacks are not admitted in ordinary conditions of the atmosphere, though doubtless they are in cases of violent commotion caused by very high wind,—the more the lower sash is raised, the more the difficulty of blacks entering between the meeting rails is increased. The principle may be modified in various ways, making the bottom frame of wire blinds supersede the strip of wood: in a word, open the lower sash of the window two or three inches, and block it up anyhow, and the air enters the space in the middle and is carried to the ceiling. Fig. 1.

The opening between the meeting rails will doubtless be found to admit more air than the various patented plans so erroneously applied to the top of the sash, whether of wire gauze, perforated zinc, or glass louvres; and while I am satisfied of a constant current of fresh air inwards, I am disposed to believe that occasionally there is a passage of heated air outwards, in which case the latter is always at the sides of the window, the fresh air rushing in at the centre;—however, provision should always be made for the escape of heated foul air from the ceiling, through a large valvular opening in the flue or elsewhere.

It will be seen that this simple plan is adapted for the cottages of the poor and the mansions of the rich: in the latter, however, the draperies *must be arranged so as not to interfere with the current*

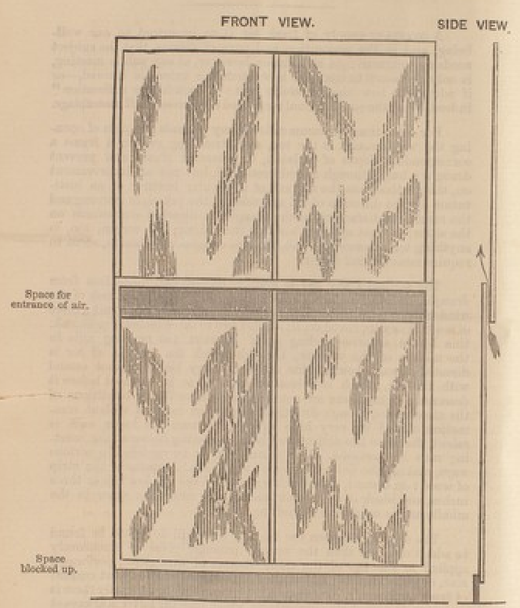


Fig. 1.

of air towards the ceiling: it may be used in any weather, day and night, summer and winter; indeed, in the house of a medical friend, to whom I had demonstrated the plan, to insure constant action, the window of his reception room has been nailed open, and the same is the case in several rooms in my own house during the milder months of the year.

But, although the above plan answers for ordinary daily ventilation, for windows without overhanging drapery,—at night, with gas in crowded rooms, it is not at all equal to the occasion: in these cases I adopt the following, also costless, very efficacious, and which may be used with overhanging draperies.

At 9 inches *above* the height of an ordinary person, say 6 feet 6, place a small hook in moulding of shutter case *furthest* from the window, on each side, and another 2 inches *below* the moulding on each side, in front of window-sill: *tightly* stretch across the window a length of linen or calico, with small loops or rings to attach to the four hooks,—leaving the calico 9 inches larger than required to hang down loosely on each side: this forms what is, I believe, technically called by architects a "hopper." Throw up the lower sash as required, and draw the blind down to the lower rail of the window sash wherever it may be. The air enters in full volume, strikes against the broad surface of the calico, and is directed upwards towards the ceiling. Here is the advantage of a window more or less open, *with privacy* and *without draught.* When not in use, this calico can be rolled up into a very small compass. Fig. 2.

The following facts may interest your readers. Before adopting these two plans, my room was generally, *at ceiling*, with four gas-jets lighted, 80 degrees of heat, when the thermometer, breast-high, stood at 65 degrees: *now*, the two thermometers are generally within one degree of each other; and in the evening, when the gas is burning and the thermometer outside at 45 to 50 degrees, with the arrangement of two openings near the ceiling (instead of at the meeting-rails), *each 5 feet by 4 inches*, and the window open 2 feet, with hoppers just described, the thermometer generally rises 2 to 3 degrees. When the thermometer outside stands at 50 to 55 degrees, I have both windows open, with hoppers in front as described, besides the two openings at ceiling,—a ventilation at such a season as this never before, by other plans, endurable. In such a wholesome atmosphere the social meal, with "the feast of reason and the flow of soul," most pleasantly runs on; probably because an *al fresco* spread is more exhilarating than one in a deleterious atmosphere. So highly do I appreciate ventilation, that I am not satisfied if I enter my home from the outside air and detect a perceptible deficiency of atmospheric purity within.

Unpatented, I with pleasure give the result of my investigations to my readers, wishing them to try the costless experiment with a piece of wood and calico, and judge for themselves; feeling assured they will find these plans recommend themselves by their simplicity, costlessness, and efficiency.

PETER HINCKES BIRD, F.R.C.S. F.L.S.

1, *Norfolk Square, Sussex Gardens, W.*

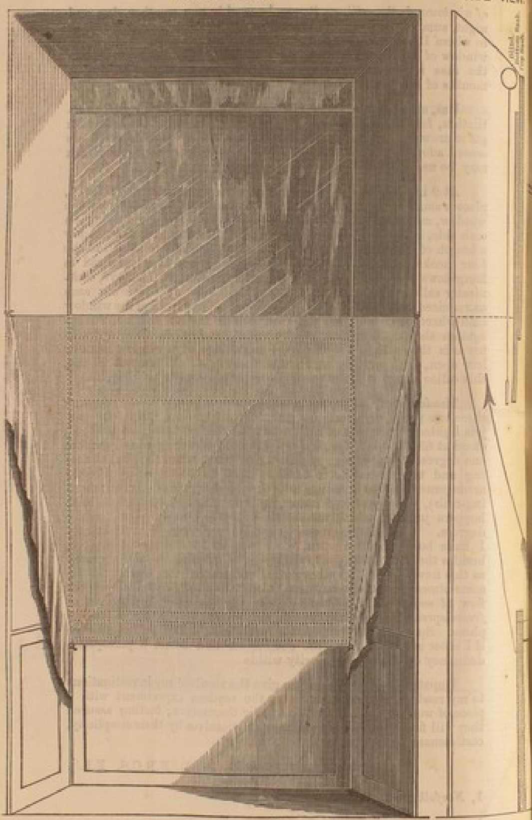


Fig. 2.

July 1864
with Author's compliments

PART THIRD.

Original Communications.

Art. I.

A Summary of some Experiments to Compare the Value of Ventilation by Pumping and Ventilation by Rarefaction. By M. Berkeley Hill, F.R.C.S., &c.

Rarefaction of the air to be removed, and its consequent displacement by cooler fresh air, is the means of renewal employed in most systems of ventilation; some plans, however, use mechanical impulsion of the fresh air, or withdrawal of the vitiated air, as an addition, or even as a substitute to rarefaction. Hence, the various methods of ventilation may be divided into three classes.

First, those which obtain renewal of the atmosphere by a continuous current of fresh air flowing in to replace the vitiated air, which, in consequence of its increase of temperature and rarity, escapes by ascending through apertures provided for that purpose.

Second, those which aid or replace the current resulting from rarefaction by one produced by machinery.

Third, those which procure the necessary renewal of the atmosphere by permitting external currents of air to flow freely through the apartment.

Difficulties of various kinds beset the working of all these methods; one common to them all is the great one of producing a sufficient supply of fresh air without creating violent draughts. Insufficiency of the supply of fresh air is the most frequent cause of failure of the two first series of plans, while the necessity for suspending the operation of the last series during bad weather renders any plan which depends on that alone imperfect and unsatisfactory.

To ascertain the value of any method of ventilation, exact and careful observations of the work it actually performs are necessary, besides estimate of the general results obtained, because it is impossible to distinguish how far these latter are dependent for success on mere ventilation, and how far on other agencies; but unfortunately, exact observations of this kind have been made on very few systems of ventilation, for which reason I trust those to which I am going to refer will prove the more interesting and worthy of narration. Their results, moreover, are in some respects very different from the opinions commonly received, which are often based on uncertain foundations.

The efficiency of any plan of ventilation will be, perhaps, more readily appreciated if the requirements of good ventilation are first enumerated.

Andral and Gavarret estimate the quantity of air expired from the lungs of a healthy man to be $11\frac{1}{4}$ cubic feet per hour, of this 0·686 (two-thirds) of a cubic foot is carbonic acid gas, being a proportion of from 3 to 5 per cent. of the expired air. In the same time, about 600 grains of aqueous vapour have escaped from the lungs and skin of the man, which vapour half saturates 212 cubic feet of air at 60° Fahr., under the ordinary barometric pressure.

Half or three-quarters of the maximum saturation is, in this climate, the ordinary condition of the atmosphere, and that most agreeable to respiration. By this dilution—i.e., to 212 cubic feet—the carbonic acid also is rendered innocuous, for it has not been shown that a proportion of less than half of 1 per cent. exerts an injurious effect on those respiring it. Peclet suggests that, in absence of more exact data, the proportion of fresh air which will reduce the vitiated air to the ordinary condition of saturation should be taken as the minimum quantity necessary to be furnished to an apartment. But this quantity, though it may be theoretically sufficient, is not found in practice to meet the demand, and consequently, as our knowledge has advanced, the ration of air has been much increased, both by enlarging the allotment of space, and by replenishing it more frequently. The minimum size of the apartment, consistent with health, may be considered to be that in which a sufficient supply of air can be circulated without subjecting the occupants to violent draughts.

But where continuous ventilation is absent, as in ordinary bedrooms, which when in use have no, or almost no ventilation, the minimum space allotted to each occupant, reckoning him to stay eight hours, and consume only 200 cubic feet per hour, is 1600 cubic feet. There can be, I think, little doubt that even this amount of space would not suffice for a healthy sleeping apartment, if all ventilation during the hours of rest be suspended. Of course, a much less space can be maintained in a wholesome condition by a continual circulation of air. Again, the size of an apartment is, to a certain extent, determined by its use. A theatre, or concert-room, may be packed much more closely without injury to the occupants than an hospital ward; those of the first being healthy, and making in it a short stay, while those of the second are permanent occupiers, and are disseminating morbific matters, which must be quickly removed lest they propagate fresh disease. Reveil found in the wards of an hospital containing cases of scarlet fever and purulent ophthalmia, the sporules of tricophyton tonsurans—or at least organic bodies resembling them—floating in the atmosphere, and epithelial debris was detected by the microscope in the dirt of the walls and ceilings of the St. Louis Hospital, at Paris.

All hospitals of recent construction in England have a much larger

space allotted per patient than their predecessors, from 1500 to 1800 cubic feet being now the average quantity; and the newest of all have the greatest space. The Parisian hospitals afford, one with another, 1500 cubic feet per bed; but the new ones contain 1900 to 2300 cubic feet. Hence the French authorities are more alive to the necessity for ample space than the English ones.

The quantity of air which experience has found requisite to preserve an atmosphere free from odour and of pleasant quality, which are at present the only reliable tests we have of the wholesome condition of an atmosphere, is generally about 2000 cubic feet per hour for each individual. This quantity was stated by the late Sir Joshua Jebb to be the amount supplied to the cells of Pentonville and Dartmoor prisons. A like quantity is furnished to the cells of the Mazas prison at Paris. In the report of a commission appointed by the French Government to investigate the subject, and decide which were the most suitable plans for ventilating the new Palais de Justice and the new theatres on the Place du Châtelet, at Paris, 2000 cubic feet is given as the amount of circulation advisable for the ventilation of buildings. To hospitals, however, the commission assigns 3000 cubic feet.

We may therefore assume—that adequate ventilation of space occupied by persons in health is supplying 2000 cubic feet per head of air saturated with aqueous vapour, from one-half to three-quarters of the maximum, not containing more than half of 1 per cent. of carbonic acid, and heated to a temperature of 60° Fahr., in such a manner that violent draughts are not created.

The external arrangement of the building is in all systems of ventilation a matter of considerable importance, as proper exposure to atmospheric currents is the only means of ensuring a pure source of air independent of advantages other than those immediately connected with ventilation.

Two of the modes of ventilation whose working illustrates the objects of this paper are erected at the Lariboisière Hospital at Paris, and were subjected to very careful examination by the French commission. It will probably assist the comprehension of the two methods if I give an outline of the arrangements of that institution. This building is also considered by French architects to be a model of hospital construction.

The part of the institution devoted to the in-patients is divided into six distinct houses. Each house is separated from its neighbours by open space on all sides, that no impediment to the external ventilation may exist. The houses or pavilions contain three wards a-piece—one ward, with its adjuncts, on each floor. The wards hold thirty-two beds, and their proportions allow a space of 1900 cubic feet per bed. Eight windows on each side admit fresh air and light. To this liberal provision for access of air to the building is added a complex system of ventilation for ensuring a regular supply of fresh air in its interior, independent of the variations of weather. These systems are not all alike, being constructed on two different principles by two different makers. The first examined is devised on the rarefication principle, and is known as Duvoir Leblanc's.

First Class.—By means of a heated exhaustion shaft, a continuous current of air is withdrawn from the upper parts of the wards. The air thus abstracted is replaced by fresh air, admitted at once from the outside of the building by flues running under the floor, and terminating in the middle of the room. This air is heated to a suitable temperature before it reaches the ward by being drawn over hot-water pipes and through hot-water stoves, whence it escapes into the middle of the room. By this arrangement a continuous current of warm air in winter, and of fresh air in summer, is directed through the wards with the following results, which were determined by repeated observations.

In the first place, the ward's temperature was sufficient, being about 60° Fahr., and the air thus heated had not acquired any unpleasant smell or dryness; next, the patients were unconscious of any disagreeable draught in any part of the room.

By experiment the air was found to be in motion throughout the ward, making a series of eddies or currents which pervaded every part. In the ordinary working of the ventilation—that is, with shut windows, for it was winter at the time the experiments were made, and the supply of air came mainly through the stoves—the amount of air coming in by this approach was about 2200 cubic feet per bed per hour. The amount abstracted from the wards being 2700 cubic feet, the difference was made up by air entering at the doorways; but if the windows were freely opened the amount extracted rose to 4000 cubic feet. Another point of importance, showing the necessity for contriving in all places of ventilation free access of air, was the discovery that the removal from the stoves of gratings and valves, which were acting as obstructions, greatly increased the supply of air, by as much as 1400 cubic feet per hour, through one of the stoves thus cleared. The exhaustive power sufficient to produce a considerable circulation of air if the passages through which it is conducted be tolerably direct, that friction may be reduced to a minimum. Hence multiplication of flues is always to be avoided as much as possible; no more should be contrived than will maintain a circulation of air throughout the apartment; and this circulation is much greater than is supposed whenever there exists a difference of temperature in various parts of the room. This fact was shown by the experiments made by the English Commission appointed in 1858 to inquire into the means for ventilating and warming dwellings. These experiments showed that in a room with an open fire or stove, if there were also an aperture for escape of the air from the room, wherever that might be placed, a series of currents were formed, some flowing towards, others from, the source of heat, so that no part of the air in the room remained in a stagnant condition. The French Commission having ascertained this (Duvoir's) system of ventilation to supply by day 2700 cubic feet per hour, made various examinations to ascertain the amount of circulation through the flues during the night, when the windows and doors are closed, and the fires slackened. At about two A.M. they found the average to be 1470 cubic feet of air

passing through the stoves per bed per hour. This quantity, less perhaps than should be supplied during the hours when the ward is closed, must not be assumed as the maximum evacuation of the exhausting shaft at that hour, because it has always been shown that more air left the wards than entered them by the stoves and flues. Probably, therefore, with larger flues the amount would have been greater during the night.

The important features of this plan of Duvoir's are:

1. A good quality of the air supplied, which is ensured by taking it at once from the open air.

2. The supply is at least 2500 cubic feet per hour for each occupant, and the principle of construction will permit a much greater circulation without raising the cost, by simply enlarging the passages through which the air is drawn.

3. The circulation is steady, and not impeded, but assisted by freely opening windows and doors.

4. There is no difficulty in increasing the circulation at seasons when a more rapid ventilation is necessary.

5. The temperature is easily maintained, and evenly communicated throughout the ward.

The cost will be given later, compared with that of the other systems.

Second Class.—The next method of ventilation examined by the Commission is one which is employed to ventilate several of the pavilions of the Lariboisière Hospital. This method belongs to the second class; that is to say, it creates the circulation by pumping as well as by rarefaction. It is called the Système Farcot.

Its theory is—air pumped in sufficient quantity into a space will, by its pressure, drive out the air already there, which is vitiated, and ready for removal.

The apparatus to produce this consists of a pump worked by steam, placed in an air-chamber, from which it drives air through flues to the wards where the flues and stoves are placed along the middle of the room, similarly to those in the system of Duvoir. The air is heated by steam-pipes from the engine boiler, which run along the flues to the stoves, and raise them to a proper temperature (about 86° Fahr.) That of the wards being about 60° Fahr. This arrangement provides about 2500 to 2700 cubic feet per hour to every patient, 2300 feet of which come through the flues. The vitiated air escapes by openings at the upper part into branch flues, leading to a common upshaft, and thus reaches the outer air. This shaft has no contrivance for heating its interior to hasten the draught, because it was intended that the evacuation of the vitiated air should be caused by the impulsion of the fresh air, and by the rarefaction it receives during its passage through the ward. The first of these influences had no effect in producing evacuation, as was conclusively shown by the following experiments:

The blower, or pump, was driven as fast as it could be set in motion, while accidental sources of air, such as open windows and doors, were cut off, that the extreme power of the pump might be ascertained. The quantity of air issuing from the flues having been carefully noted, the blower was stopped, while the means of access of air remained the same. The volume of air which then issued from the flues was solely due to the rarefaction power of the system, and its amount was found to be one-third less than that of the first.

But when new apertures were made into the air-chamber, to permit a readier approach of air to the flues, this loss of one-third was made good. This equality, moreover, was not upset when the pump was again set in motion, for this time the result appeared about the same in the various wards, whether the blower worked or not.

While the blower was in full motion, and the windows, &c., closely shut, the barometric pressure without and within the ward was carefully observed, and a slight preponderance was found to exist outside, for at no time was the density of the air greater within the ward. In this way the supposition that the pump was able to expel the air from the ward by the pressure of that it drove in, was at once disproved, and the rarefaction power was shown to be sufficient, imperfect as it was, to withdraw the air faster than the pump could drive it in. The quantity of air passing out of the wards being always greater than that introduced by the flues, the deficit was supplied through the doors and chinks of the windows.

The removal of the foul air under this system was unsatisfactory. When the windows were shut, its extraction continued with tolerable regularity at the rate of 2500 to 2700 cubic feet per bed per hour; but if free opening of the windows was attempted, the exit of the vitiated air at once became disturbed, and, in high winds, reflux of foul air into the wards was observed, while the quantity evacuated diminished to about half its usual amount. This irregularity was, no doubt, caused by the want of appellant power in the up-shaft itself, and is a very serious disadvantage of this system.

A peculiarity of this system, worth dwelling upon because it has been advocated by ventilating engineers, and, unless carefully examined, appears a valuable arrangement, is this: to ensure a supply of pure air to the forcing-pump a tube was carried from the belfry of the chapel to the air-chamber of the pump, in the basement of the building; the air thus obtained would be, it was hoped, quite free from the impurities contaminating the air near the earth's surface. The experiment showed that when access of air to the chamber, except through the long tube, was prevented as carefully as possible, only half the air which reached the wards through the flues came from the belfry of the chapel; even more, if the doors of the air-chamber were but loosely closed—as, of course, often happens, only one-fourth part of the air came down the tube the rest must, in both cases, have entered the flues through joints and chinks. These results make it clear that considerable disadvantages attend this plan for obtaining air from a pure source, and that its adoption induces a false security, for under the impression that the air they were driving into the

wards was pure, the inventors were supplying air taken from cellars, and other localities of a suspicious kind.

Another disadvantage of circulating air through tubes is the impediment friction causes to its flow; this is common to all plans where air has to pass through narrow channels, but where, in addition it is impelled into the flues, a considerable amount is lost by leakage through the joints during its passage, the amount lost being proportionate to the imperfections and length of the tubing traversed, and, in this instance, was about half the volume impelled.

General Morin, Directeur du Conservatoire des Arts et Metiers, at Paris, and the most active member of the French Commission, was anxious to ascertain how much obstruction to its passage a current of air received by passing through narrow outlets, and conducted some experiments with the view of measuring the impediment, from which it would appear that the difference in the volumes which passed apertures of different sizes, other things being equal, was in proportion to the difference of the square-root of their areas. The velocity of the current was accelerated through the smaller openings, and yet this increased flow did not restore the balance.

These various observations show that air-conveying tubes must be short, capacious, and as straight as possible, and also that serious loss must take place when air is forced through them. If air be drawn instead of driven, the leaks are of less consequence, as they help to supply the quantity arrested by the friction, though the air they contribute is from suspicious sources.

Another plan of ventilation in which mechanical pulsion is employed is that of Dr. Van Hecke; but this apparatus, tested at the Vesinet Convalescent Institution and Necker Hospital, was so defective in its working, and the ventilation it effected so obviously inferior to that of the other two systems, that a description in this place is unnecessary. Dr. Van Hecke has in some instances applied his pump to force fresh air into the wards; in others to drive the foul air out of the space to be ventilated. In the first, in consequence of the want of a good plan for providing a steady draught, the removal of the vitiated air was very defective; in the second this was more regular, but the supply of fresh air was insufficient. The inferiority of Van Hecke's method was so evident, that it did not long engage the attention of the Commission.

Third Class.—By this method most English hospitals are ventilated; and if the rooms are large and lofty, it is a tolerably successful one, though, of course, it must be frequently interrupted by bad weather.

An adaptation of this kind is a plan recommended by Dr. Roberton, in his article on "Hospital Construction," published in the 'Transactions of the Manchester Statistical Society' for 1858. That gentleman suggests the construction of openings in the walls of the ward near the ceiling, placed opposite to each other, protected by a wide-meshed grating. The external currents of air flow through these openings, and sweep away in their course the vitiated air as it rises to the top of the room, without causing violent draughts in the lower part. This method is, perhaps, the best in which external currents can be employed in ventilation, but by itself is insufficient, as no provision is secured for carrying on the ventilation when inclemencies of weather necessitate the closure of these apertures. Also the quantity of air admitted by this means cannot be accurately measured. It is probably more than 2000 cubic feet per bed per hour, because it suffices to preserve the atmosphere in a sweet condition, which that quantity failed to do at all times in the Lariboisière Hospital, notwithstanding the scrupulous cleanliness practised in other respects.

From this summary of the experiments, it is evident that many erroneous conclusions exist of the efficacy of different methods of ventilation, especially of those in which impulsion of air is employed as a means of creating circulation. While from the results of the experiments the following principles for guidance in contriving a system of artificial ventilation may be extracted. These are—

1. 2000 cubic feet of air per hour is about the minimum quantity which suffices to preserve a wholesome atmosphere in an enclosed space occupied by human beings.

2. Rarefaction can supply a sufficient quantity if the rarefaction be created in an upshaft; so that the cause of the draught of the vitiated air is removed from the influence of adverse currents of air.

3. Impulsion of air into a space is an inferior means for procuring a circulation than exhaustion from it by rarefaction.

4. Currents of air are much retarded by passing it through narrow channels, and the available supply is much diminished.

5. Pure air can be obtained with certainty only by admitting it directly to the apartment. The longer it is detained in tortuous passages, the more it is contaminated by air from accidental sources; hence arrangements for bringing air from a considerable height above the earth's surface defeat their object by the leakage they cause.

6. Ventilation by rarefaction, properly conducted, is not disturbed by free ventilation through open windows, when the latter is desirable as an auxiliary, and it affords a permanent and steady supply of air at all seasons of the year, when windows cannot be opened.

The system of Duvoir Leblanc, by this examination, was shown to be, in the opinion of the French Commission, decidedly superior to either Farcot's or Van Hecke's, from its greater excellence of principle. It was the system selected for the ventilation of the Palais de Justice, after having received improvements in the mode of admitting the air, suggested by the observations made on its working at the Lariboisière Hospital.

The plan adopted for ventilating the two new theatres of the Place du Châtelet is a modification of this rarefaction in the evacuating-shaft, being the means of procuring a circulation of air.

The theatres are warmed by means of air heated in furnaces, instead of over hot-water pipes, because in this way the rise of temperature is most rapid; also because the fresh air needs little artificial warming after the audience is assembled, when the heat generated in the furnaces can be conveyed at once into the evacuating-shaft, to increase the draught.

The circulation of air through the theatres is contrived in a very ingenious way. In order to prevent the rapid draught of air from the stage to the shaft over the central gaselier occurring in ordinary theatres, but which is of very little service in ventilation, as it does not affect the air surrounding the audience, the mouth of the shaft is no larger than will permit the escape of the products of combustion of the gas-jets. This small quantity of air is very highly heated, and tends to quicken the draught through the main shaft into which it rises. It is aided in this by other accessory sources of heat, which are —a group of gas-jets burning in the shaft; the passage of the furnace smoke-flue through it; hot air brought direct to it from the furnace; the products of combustion of the foot-lights, &c., which are led up to the main shaft by separate flues. A rapid exhaustion and rarefaction results from this supply of heat, which is utilized in the following way: exit-flues communicate with the theatre in the floor of the pit, in the boxes, and between the rows of seats of the galleries; and the foul air is sucked away through the flues from among the audience where it is generated, whither also it is necessary to lead a fresh supply. This fresh supply is poured into the theatre by an ingenious arrangement, which is devised as follows: beneath the pit of the theatre are placed two large air-chambers, where the cold air is mixed with the hot air from the furnace, and thence drawn along flues into the theatre by the exhaustion going on there. These flues are conveyed to various parts of the house, and project fresh air into the theatre along the front of the stage, at the wings, and in front of each tier of boxes, on a level with its floor. The currents of air thus made to blow directly into the theatre lose their force and direction before they reach the audience, to whom a steady, imperceptible current of fresh air is induced by the abstraction going on around them. The amount of air estimated as supplied by this method is 1500 cubic feet for each spectator when the theatre is two-thirds full; when quite full, the supply is about 1000 cubic feet. Means for introducing an additional quantity are provided for the summer requirements. The success of this method of ventilation is decided, though not quite so perfect as is desirable. During the recent hot weather I had an opportunity of comparing the atmosphere of these two theatres with that in the older ones ventilated by the ordinary method, and the comparison was much to the advantage of the new theatres.

The cost of the different systems of ventilation was calculated by the Commission at the following amounts:

	Duvoir.			Farcot.			V. Hecke.	
	£	s.		£	s.		£	s.
Cost of erection per bed . .	19	0	...	32	0	...	9	10
Annual cost	2	9	...	3	16	...	1	9
Ditto with 10 per cent. on first outlay . . .	4	7	...	9	0	...	2	8

The cost of 1,000,000 cubic feet under the different systems, supposing Duvoir and Farcot to supply each 2500 cubic feet per hour, and Van Hecke 1400 feet :

Duvoir.		Farcot.		V. Hecke.
4*s*. 0*d*.	...	6*s*. 4½*d*.	...	3*s*. 11*d*.

But it must be recollected that Van Hecke's system is very irregular in its working; and consequently the estimated 1400 cubic feet is little more than a guess. It may, therefore, be considered more costly than Duvoir's, as well as less efficient.

This account of the testing to which these systems were subjected renders it clear that the only plan of ventilation thought worthy of further adoption by the French Commission was one which had exhaustion by rarefaction for its principle of construction. All the plans of ventilation were insufficient in the amount of air supplied ; but the experiments of the Commission showed that this difficulty is most easily surmounted in the plan of ventilation by rarefaction, where the supply appears to be illimitable with a well-arranged apparatus. This description, I trust, will serve to render these principles of ventilation more familiar to those interested in this subject.

Art. II.

Sketch of the Geography of Epidemic Yellow Fever since the Close of last Century. By Gavin Milroy, M.D., F.R.C.P., President of the Epidemiological Society, &c.

After an absence of a good many years, yellow fever in an epidemic form manifested itself afresh about 1793 in the West India Islands, and at several points of the American Continent, between Guiana to the south, and the seaboard of Pennsylvania and New York to the north. The imperfect data on record seem to indicate that Grenada, Dominica, Barbadoes, and Jamaica were among the British islands first attacked; but that, prior to their invasion, the disease had been prevailing in Charleston and other southern cities of the United States, as well as on the coast of Guiana and the adjacent settlements.

The expeditionary force under Sir Charles Grey, sent from this country soon after the outbreak of the great revolutionary war for the capture of the French West India colonies, arrived in those latitudes in the early part of the epidemic season, and at once encountered the pestilence. During the reduction of Martinique, St. Lucia and Guadaloupe, and the subsequent occupation of St. Domingo in 1794, the loss of life among our troops, chiefly from malignant fever, was enormous. Of the 10,000 men composing the force, 6000 perished within a few months. Several regiments returned to Europe, after a short stay, mere skeletons of what they were. The 82nd lost within twelve months of their arrival in the West Indies upwards of 800 rank and file and officers, and mustered on their return not men enough to complete the number of their non-commissioned officers! Part of the 92nd also, engaged in St. Domingo, "were soon exterminated to a man." The whole of this dreadful mortality was not due to yellow

A few Additional Suggestions, with a view to the Improvement of Hospitals for the Sick and Wounded.

By Mr. John Roberton.

[Read March 31st, 1858.]

In a former Paper, on defects in the construction and ventilation of English Hospitals, read March 20th, 1856,* I endeavoured to shew that the insalubrity of a number of our Hospitals arises mainly from two causes — first, the difficulty, owing to faulty construction, of securing a free circulation through the wards, and a continual renewal therein, of the external atmosphere; and second, the intimate connection existing between the different wards in each storey by means of doors and passages, and between the different storeys by inside stairs — an arrangement which favours the rapid diffusion over the house of the foul air generated in any one of the wards, and consequently the creation of an Hospital atmosphere. I further attempted to shew that, by adopting a plan of construction such as may be seen in the beautiful Hospital at Bordeaux—the structure which has supplied a model for the best Hospitals in Paris and Brussels — all the difficulties hitherto experienced in English Hospitals, with reference both to the ventilation and to the proper isolation of every single ward, may easily be surmounted.

* Reprinted in the form of a Pamphlet (including the lithographed sketch of the ground plan of the Bordeaux Hospital) from the Transactions of the Manchester Statistical Society, May following, and forwarded to the medical officers of the London Hospitals; to the heads of the Army medical department; to the officers of the General Board of Health, &c.

Moreover, in the Paper referred to, I took occasion to state that, though so-called "scientific" modes of ventilation by fans, pumps, flues, pipes, and furnaces may answer in saloons and public offices, they fail when applied to an Hospital, for the purification of which, and the maintenance of whose purity, no description of ventilation ever has, or, I venture to think, ever will be found to answer, excepting *that* by means of properly contrived lateral windows, other kinds of openings facing each other in the walls, and open fire places.

As exception has been taken to my comments on what is called "scientific" ventilation,* I beg to observe that I have little to say regarding it, unless as applied to Hospitals; but I here repeat what I formerly stated, that so wide is the difference between the wants of a ward filled with the sick and wounded with respect to ventilation, and the wants of every other kind of apartment in which people in health congregate or lodge, that the means which are found sufficient to maintain the purity of the one fail in maintaining the purity of the other; and an architect who has not submitted to make himself familiar with the state of the atmosphere in, for example, the crowded wards of a badly constructed Hospital at those hours of the day and night when the admission or the exclusion of air is left to the nurse and patients, is ill qualified to form an opinion on ward ventilation. Until the architect will consent to give his organ of smell a few minutes' practical training, about six or seven o'clock in the morning, in a crowded surgical ward, he can never realize the importance of a truth, which can hardly be enunciated with too great emphasis—that not merely must a ward, if it is to be kept sweet, be ventilated in the ordinary sense of that term, but it must be so ventilated as to secure for it *the constant renewal of the contained air*—the displacement of the fœtid effluvia ever being emitted from the bodies of the sick

* See a letter in the *Builder*, No. 759, page 485. The editor of that valuable periodical, however, I am happy to observe, understands the *true* science of ventilation, and is rendering, from time to time, important service to humanity by his articles on the subject.

and wounded, and the substitution instead, of air, not drawn from cellars, corridors, and passages, but admitted direct from the store of the unpolluted heavens.

Moreover, it should not be forgotten, when the purification of an Hospital is under consideration, how liable "scientific" modes of ventilation are to disappoint, owing to derangements occurring in some of the valves, pipes, or other parts of the apparatus; insomuch that the most renowned inventions of this sort are ever being pronounced failures, and so given up. Nature's ventilation—the unceasing flow, parallel to the earth's surface, of the atmospheric tide—may be depended upon. Only let there be openings, facing one another, in the side walls of an apartment, and a through current of air never ceases: it flows on with the same certainty that may be predicated of the law of gravity itself. That man's ventilation is less worthy of dependence, the following instances may help to show:—

In 1853, I had occasion to visit, with a friend, one of our county jails. We entered a vast covered court, round which, in a succession of storeys, were galleries leading to the cells. After gazing about for a little I asked the governor to take me into a cell. He replied, "I may as well warn you that you will find the cells close and unpleasant." On entering one, I said, "This is indeed bad! have you no means of ventilation?" He answered, "Yes; we have a furnace at the top of the jail, and, in connection with it, tubes, the mouth of one of which is in every cell,—you see one here; but, somehow, it don't act well. When a cell becomes very close, I take a pane from the window and make a counter opening over the door, and then it is better." The Governor, it is plain, had small faith in the furnace at the top of the jail. One Christmas Eve, a few years ago, I had to see, professionally, a member of the House of Commons just come off his journey from London, who told me that he had been at a lengthy sitting the preceding night, and that the closeness of the House had very much exhausted him. I said, "Is the air, when you have a full House, and have sat long, disagreeable and close?" "The air close!" he replied;

"one may *taste* it." "Have you not the finest, most costly 'scientific' ventilation?" I asked. "Yes," he replied, sarcastically, "when the weather permits the windows to be opened, *then* we have *good* air."

It may here be proper to say a word on the cause and the prevention of draughts in a ward, for the subject is very little understood. Suppose, on a calm day, the tops of the windows facing each other in the side walls to be open, there will be no draughts, because the air, as it enters at one side, displaces at the same instant an equal volume of air on the other side, and that without sensible agitation of the atmosphere in the apartment; but, let the windows on one side be shut, and those opposite remain open, and immediately there are draughts. The through circulation having been interrupted, the external air, as it flows into the apartment, mingles with air of a higher temperature than itself, condenses it, and thus produces eddies and currents which are anything but agreeable to the feelings of persons exposed to them. A lady, a zealous Sunday School teacher, once complained to me of the oppressive state of the air in the school. On inquiry, I found that the ceiling was low, and that the room was crowded with scholars, but that there were windows on the opposite side walls. I recommended that a pane of glass should be taken from the top of each window, and replaced by a finely perforated zinc plate, which was done, and the change that followed was all that could be desired—teachers and scholars alike were delighted with the freshness of the air, and I was assured that there was no draught whatever. Soon afterwards I met a friend who had been at an evening meeting in the school room, and who informed me that the place was very draughty. I inquired if there were window blinds, and if these had been drawn on one or on both sides. He replied that there were window blinds only on the side towards the street, and that *they* were drawn. I explained to him that the draughts arose from their having lessened the communication with the external air on one side, and left it free on the other, and that if they would have blinds on both sides alike, or no

blinds at all, there would no longer be draughts. It is important, also, to know that the openings in the external walls should directly face each other; that these openings should be the same in dimensions; and, if filled with zinc plates, that the apertures in the plates should be alike in size. Without attention to these simple rules, through ventilation will be less agreeable to the sick than it might be.*

My estimation of the value of these views concerning natural ventilation was strengthened and confirmed in the course of a tour that I made last summer in Belgium and parts of Germany. In the Hospitals of Ghent, Antwerp, and Liege, which are all two centuries old or upwards, I found the wards in every instance ventilated by windows facing each other in the side walls; when the wards were more lofty than common I observed, sometimes, two rows of windows one over the other in the opposed side walls; and in no case did I see a ward traversed by a corridor or divided longitudinally by a partition, so that *through* ventilation might always be obtained by windows and apertures. Considering the antiquity of these Hospitals—that of Liege dates from 1602—I could not but feel pleased with their construction; as I was, too, for the most part, with the other arrangements for the benefit of the sick. Not that the wards were, in every instance, separated in such a manner as to prevent injurious inter-communication by passages and stairs;

* The first notable instance of through ventilation that I remember to have seen was a number of years ago, in the Kilkenny Workhouse. The house was pretty full, yet not so crowded as it had at one time been. I asked to look at the dormitories. On entering one—a men's—I saw a long, lofty apartment, of no great width, with a row of beds on either side, windows facing one another in the side walls, and not far from the ceiling between each opposed pair of windows a transverse opening in the wall, perhaps six inches in breadth, filled with a plate of finely perforated zinc. I was startled at this free, continual admission of the air immediately over rows of beds, and asked the Governor if the people who slept there did not take cold. "No;" he replied, "I never heard of their taking cold: but two or three years ago, when we had many more in than at present, they used to lie packed as thick as herrings, almost, and could not have lived without plenty of air." The new Irish workhouses are planned with much good sense and skill, and they well deserve a visit from the curious tourist. Our barrack architects, too, might find them worthy of a visit.

nor that the *latrines* were always well placed in relation to the wards, or well ventilated; nor that the cubic air space was always what it ought to be; but my meaning is, that, comparing these ancient Institutions with the Infirmaries in our own large towns, most of which have been erected within a century, I could not but be struck with the inferiority, in nearly every respect, of the latter.* On proceeding northwards through Germany I was soon made aware that, in leaving Belgium, I had made a descent from a high to a somewhat lower social condition; so far, at least, as we might judge by the intelligence displayed in the construction of Hospitals. In the new one at Cologne, built to accommodate 600 sick, I first saw that plan of construction, found in every Hospital I subsequently visited—in Hanover, Hamburgh, Berlin, Dresden, Leipsic, Frankfort, and Bonn, and which seems peculiar to Germany. The building is of two or three storeys, and, when large, it forms three sides of a square. The wards in each storey range within the outer wall, and behind the wards there is a corridor: it follows that a ward, bounded thus behind by the corridor wall, and, laterally, by partitions which separate it from the wards on either side, will derive its light and air mainly from the windows in the front or outer wall. True, in the wall of the corridor is a door, and sometimes over this door a window, but these contribute little to the ventilation; and, as a ward is always deeper, from front to back, than it is transversely, and as a through current cannot be obtained, good—that is, sufficient—ventilation is next to an impossibility. There is another evil in a number of the Hospitals, which I saw with surprise: in the side walls are doors that open into the ward on either hand, thus establishing a direct inter-communication among all the wards in a wing—

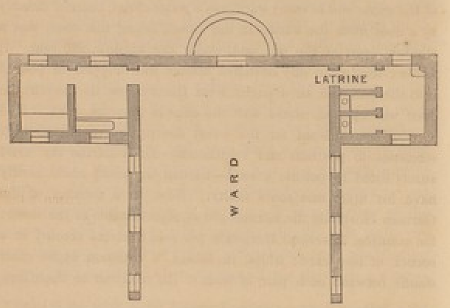
* Some of the wards in the Belgian Hospitals are too wide. One in the Hospital at Ghent was of great width, and contained, longitudinally arranged, six rows of beds; but then the windows in the opposite side walls were very lofty, and there was a vast arched roof, in form not unlike one of our railway sheds. The wards in the Bordeaux Hospital, with reference to width and height, and to the number, position, and size of the windows, supply, perhaps, our best model—certainly the best I have yet seen.

let only one ward be foul, and the other wards are sure to partake of the impurity. When a ward happened to contain little more than half the number of patients it was intended to lodge, one's sense of smell, possibly, received no shock; but, with the full number of patients, it was generally otherwise. Indeed, judged by this test, a visitor would be sure to complain of the state of the atmosphere;—a state of impurity, however, arising not alone from the obstruction, by the corridor, of through ventilation, but in part from other bad arrangements which I proceed to notice.

Nothing, perhaps, exhibits more strikingly the errors of Hospital architects than the bad position of the latrines, and the faulty methods devised for their ventilation. I was particularly struck with this some years ago, when looking through an Infirmary which had been only a short time opened. The wards in each storey were four—two on either side of a corridor—and at the gable end of every ward was a water-closet, entered directly by a door from the ward: in the closet, facing this door, was a window open at the top, and, under the window, the seat. It follows that when any offensive matter was dropped or poured into the pan, the air draught from the window, the instant the door was opened, would waft the effluvia into the ward! Had a prize been offered for the worst description of latrine with reference to position and ventilation—for a latrine the most surely fitted to pollute a ward—human ingenuity could hardly have hit upon one more faulty. Now, in a number of the German Hospitals the latrines are as objectionable as the above; for example, in several Hospitals one sees a latrine erected in a corner of the ward; while, in others, a common night chair stands between each pair of beds.* In addition to these two

* My friend Mr. R. Johnson, who lately paid a visit to the Hotel Dieu, Lyons, writes me that he found "night chairs, curtained off, one in each ward, and emptied once a day"—a most disgusting arrangement. Provided, however, that night chairs were fitted up as portable water-closets, and carefully seen to by the nurses, such night chairs might be a great convenience and benefit to the sick. Still, without attentive nursing, night chairs in wards must be an evil.

kinds of ward conveniences there is in general a large common latrine in each wing adjoining to and entered from the corridor, having a window facing the entrance, so that the cold air from the open window necessarily carries the effluvia from the latrine first into the corridor, and thence again by the doors into the wards. In none of the German Hospitals which I inspected were the latrines properly placed or well ventilated; in most they were decidedly bad: whereas in Belgium—to say nothing of the St. John's Hospital, Brussels, which is a model in certain respects for its latrines—I do not recollect one of the old Hospitals in which the latrines were placed within the wards;—in two instances they were in an adjoining garden, near to, yet sufficiently separated from the building to prevent any impurity finding its way into the wards.



SKETCH OF THE OUTER HALF OF A WARD IN THE ST. JOHN'S HOSPITAL, SHOWING HOW THE LATRINE IS VENTILATED.

In regard to *position*, the latrines ought to be joined with the ward so that the sick can pass into them without risk of taking cold, and so placed as to have no ventilating communication with the ward. Now the reader will see in the ward plan of the St. John's Hospital, that the latrine is entered from the ward by two doors, an inner and an outer, and that the latrine forms a separate building. With reference to purification, he will observe that the seats are against the outer wall of the ward, and that the position of the two latrine windows, supposing them open at the top, secures a through ventilation of the apartment, and that, too, (which is all important) in a direction at right angles with the passage from the ward, into the latrine. I do not see how it would be possible to improve upon this plan as respects position and ventilation. The apartment, I ought to say, is large and lofty, having windows the same in form and height as those in the ward.

I use the word "latrines" in the sense of *lieux privés*, without reference to the mode employed to carry off the soil. A considerable proportion of the latrines on the continent are not water closets. In the St. John's, I noticed a pump in the room, from which a certain number of buckets of water is drawn daily to pour into the pans. I omitted to ascertain if the pipes conducting from the pans are trapped, but, judging from the freshness of the apartment, such was probably the case. We are apt to forget, in this humid, temperate island, that our neighbours across the Channel have their rivers frozen when nothing of the kind occurs in England—that in winter the Scheldt, the Maese, and the Elbe are usually for many weeks bound in ice; and that it is this freezing cold which, to some extent, interferes with the general adoption of water-closets. Once, a friend from Toronto casually remarked to me, "I never saw a water-closet till I came on board the English steamer." "What!" was the reply, "have you no water-closets in Canada?" "No; our climate forbids." However, let the latrine be a water closet, or only a pan and pipe cleansed by the water bucket (and for an Hospital the self-acting water-closet is ever to be preferred) the pipe, in either case alike, ought to be trapped, and strict attention given, from time to time, to ascertain that the drain is clear.

Capped tubes, penetrating the walls a few inches from the floor, are used in continental Hospitals for the occasional ventilation, or, more correctly, for the occasional flooding with air of a particular part of a ward. This contrivance I noticed for the first time in the Hôpital de Bavier, Liege. Every surgeon knows, when the dressing is removed from a burn, a wound, an ulcer, or an abscess, that, sometimes, the fœtor is intolerable; and the same will happen in certain states of disease, when the patient is on the bed pan. Now, it is in such circumstances, by uncovering the mouth of a tube four inches in diameter, communicating, near the floor, with the external atmosphere, that the locality is instantly flooded with fresh air, and that, too, at so low a level as not to incommode the patient; when a tube in the opposite wall is at the same moment uncovered, the flood of air is such as allows of both tubes being speedily closed.

I am opposed to the use of gas on account of the glare it causes, as well as of the risk of escape into the ward through defects in pipes or burners; but there can be no objection to a single gas jet in the nurses' room, for convenience sake. In Belgium and Germany I found no uniformity as regards the means of lighting; in a number of Hospitals oil lamps are alone used, in others gas; and in some, again, gas sparingly, along with oil lamps: I decidedly prefer lamps.

The material of which ward floors should be composed would be easily decided had we marble in such abundance as one sees in the Low Countries. In Holland, all the better class of shops are flagged with marble; and the lobbies, and even the steps of stairs in the houses of the opulent, are of beautiful polished marble. The first ward I entered in the St. Elizabeth Hospital, Antwerp, had a polished marble floor; but this did not extend to all the wards. At Cologne, too, some of the Hospital corridors were paved with marble. In the Hospital at Liege, the

floors were of oak, cleansed twice a day; and unquestionably, saving marble, the best material for the flooring of wards is oak, painted, waxed, or varnished, as in the great Hamburgh Hospital, and, I think, in several more of the Hospitals I visited; for it is easy to clean, and when moist can be speedily rubbed dry. The principle—which cannot be too strongly urged in reference to the floors, walls, and ceilings of Hospitals—is, that every kind of porous material ought to be avoided. If all the interior surfaces of an Hospital were of some material like glass, hard, smooth, and polished, so much the better for its sanitary condition.*

There is one important matter more cared for on the Continent than in this country—I refer to the means of recreation for the recovering sick and the convalescent; a pleasant out-look when the sick are not able to go abroad, as on the balcony at the outer end of the ward in the St. John's Hospital; and convalescent's rooms for meals; reading-rooms and libraries; terraces where they can walk, and take the air, and gardens in which, at certain seasons of the year, they may have the liberty to wander: nay, gardens into which the sick may be wheeled in their beds or couches,† and where, under the shade of trees, or under sheds erected for their special use, they can enjoy a sight of the heavens and breathe the external atmosphere. Who can think of this kind of enjoyment in a person so recently pining

* See, in the *Builder* of December 5th, 1857, page 799, a curious and interesting notice of "Water Glass," and its applications. This is a kind of cement having a powerful chemical attraction to mortar, brickwork, &c. drying quickly, being very durable, smooth, and hard, like glass. How far it may be found suitable for coating the walls of Hospitals, I do not venture to determine.

† My friend, Mr. P. H. Holland, late of the Board of Health, in a letter to me, remarks: "It is a great mistake to allow patients who can get up to spend the day in the sleeping wards. Nay, I much incline to have beds on wheels, so as, if possible, to empty the sleeping wards some part of every day, that all the windows might be thrown open.".

on his mattress, it may be for weeks or months, without recalling the stanzas of Gray:—

"See the wretch that long has toss'd
On the thorny bed of pain,
At length repair his vigour lost,
And breathe, and walk again:
The meanest floweret of the vale,
The simplest note that swells the gale,
The common sun, the air, the skies,
To him are opening Paradise."

I shall not soon forget my feelings when, on leaving the great Charité Hospital, Berlin, I wandered on a warm, fine morning (September 4th, 1857) into its gardens behind, and came upon one of the patients, a sick man, on his bed, set under an apple tree, which spread over him its branches laden with fruit; nor, the pleasure I enjoyed a week previously, in walking through the gardens belonging to the Liege Hospital, whose Governors are amusingly provident for the recreation, but especially for the corporal wants, of the inmates. There you see courts adorned with trees in painted tubs, as at Versailles; fruit gardens, and an ample kitchen garden; six cows kept to furnish unadulterated milk; and poultry, I know not how many, for the supply of *fresh* eggs. But here in England we are too apt to forget these secondary yet most important means of restoring bodily health through the mind—of seconding medicine by what exhilarates and cheers the wasted and suffering. I formerly mentioned the flower gardens for the use of the sick, which separate each pair of pavilions in the Hospital at Bordeaux; and I here give a passage from the letter of a friend, written at Paris in 1855, describing the recreations provided for convalescents in the Hospital Lariboisiere:—"These several sweet Hospitals—[he refers to the separate pavilions of which the Lariboisiere consists] are built fifteen or twenty yards apart, and the space between them is a grass plot and garden, for the use of the patients when permitted to go out. The windows all looking into these

gardens, they are a source of continual pleasure to the patients. The advantages of this construction are so obvious that I will not weary you with naming them. The first floor in each block is the same as the ground floor, except that, as I have already stated, those who may take out-door exercise have to walk upon the corridor which looks upon the beautiful square with its garden beneath. The upper storey is the same, the patients coming down for out-door exercise. I was delighted to find a library and lecture-room for young convalescent patients. This is as it should be. There is a similar room for adult patients; and I remarked that in it rush-bottomed chairs took the place of forms and benches."*

The drains from an Hospital demand the utmost care and good management—in particular that they be constructed so as easily to *scour* when flushed; that the main drain do not pass under the building; that every pipe from water-closet, lavatory, bath, nurses' room, and kitchen, be trapped; and that these outfalls be inspected by some competent person at least twice a year. The mischiefs that may arise from a bad main drain I will illustrate by an example. Having occasion once to visit a jail in course of erection, on business with the master of the works, I observed, before entering, workmen busy constructing a main drain after the old fashion, that is to say, a culvert of common brick laid without cement, the bottom, of course, rough and uneven; and there being very little fall, no flushing, it was obvious, could scour it. I said to the master of the works, "If you are to have here six or seven hundred cells, and every cell its water-closet, will not this rude kind of drain lodge filth, and be continually sending back upon you its volumes of putrid effluvia?" He replied, "I have been saying the same thing, but the borough surveyor does not heed me. It was otherwise in the last jail I built, which had its main constructed thus: bricks cast to the proper curve, and set in cement, constituted

* From Mr. R. Johnson's letter, giving an account of the Lariboisiere, referred to in my former Paper.

the bottom of the drain; and so smooth was it that a moderate flow of water sufficed to keep it clear." Subsequently, I learned from an officer belonging to the jail that they had been inundated with fœtid gas; that, after trapping the outfalls from every cell and closet, the gas still found a way into the building; and that it was only on discovering that they had overlooked the outfalls from the baths, and trapping these, that the bad smell ceased. It ought never to be forgotten that a badly-constructed drain is always a reservoir of poisonous gases, and also that it is liable to become gradually obstructed, until at length it is no drain at all.

The water used in an Hospital ought, of course, to be pure and good;* but what I would here advert to is the custom, so general in England, of using lead cisterns for storing water, especially where, as in many of our towns, the supply is intermittent. Such cistern water is always tainted with lead; not in quantity, it may be, to produce the distinguishing symptoms of lead poisoning, but enough to affect very injuriously the stomach and nervous system of persons habitually using it. From experience I can affirm that, if boilers in an Hospital are fed from a leaden cistern, and if taps, connected with these boilers, are placed so as to be convenient for nurses and other servants to draw from, the patients, instead of the wholesome prescribed water, will be certain to get the tainted; the tap that is the readiest will be ever the tap used.

An unhealthy Hospital will unquestionably exhibit a high rate of mortality; nevertheless it is an error to suppose that the death-rate is in every instance a correct test in reference to the sanitary state of an Hospital, since a high ratio of deaths will sometimes proceed from causes independent of this circumstance. Thus, for example, in a town where people are much employed in machine shops and foundries, the Hospital *there* will be sure

* On this subject the reader is referred to Dr. Snow on "Cholera, and the Water Supply in the South Districts of London." *British Medical Journal*, October 17th, 1857, page 84.

to receive a larger proportion of severe casualties—of cases likely to swell the death-rate—than will happen in another town where few are occupied in connection with machinery.

The first thing to be regarded in an inquiry into the good or bad sanitary condition of an Hospital is, perhaps, the health of the resident officers and nurses. If the atmosphere in the wards and passages is foul, it may be expected that persons attending on the patients will not enjoy vigorous health; and the truth of this test is confirmed by general experience. I remember, one night, when wandering through the wards of an excessively foul Hospital, in which were scenes of suffering that words would fail to pourtray, being particularly struck with the sickly look of the nurses and medical pupils: nor did this surprise me, for I felt that had I been obliged to remain in the building for only a single night, I should myself have been on the list of sick, solely as a consequence of the state of the atmosphere.

A second, and far more decisive test, however, is the tendency in wounds, received by accident or made by the knife of the surgeon, to heal speedily or otherwise—to heal, or not to heal, as quickly as would happen were the same cases treated singly in a commodious private house. And if an Hospital do not afford advantages equal to the best private dwelling, it is assuredly, to use the mildest term, a failure—I might, perhaps, without impropriety, say—a snare and a curse. Yet in how few of our Hospitals is it that compound fractures, amputations, the excision of large tumors, and the like, do not linger far longer than they would were they treated at home. The test referred to has never yet, I imagine, been applied to the results of Hospital practice, else it would have brought into open day a mass of harrowing evidence as to the weeks and months of suffering needlessly inflicted on multitudes of the most valuable members of almost every industrial community in England, who have had cause to bewail the evil fortune that sent them into an Hospital; to say nothing of the waste of Hospital funds, owing to the enormous enhancement of expense in the treatment of every such lingering case; for it would be wrong to overlook the fact that perhaps every social evil, not excepting the present, admits of being estimated at its money value.*

In the recent Report on the sanitary condition of the army, and the organization of Military Hospitals, to which I shall have occasion before concluding particularly to advert,† we have, in the evidence of one of the witnesses, the following facts, with regard to the present sanitary condition of Guy's Hospital:—Sir James Clark asks, "Do cases of erysipelas occur in the wards?" The witness replies: "Very frequently in the surgical wards; not in the medical wards."—Have you any cases of pyæmia?" "Yes; cases of pyæmia occur very frequently in the treatment of severe surgical operations, and render them very fatal." Now, had the surgeons of a large proportion of the Hospitals in Great Britain and Ireland the same questions to answer, and were equally free and candid as this witness, what disclosures should we not have! Let us hope that, as the deadly barrack dormitories have at length found a Howard in Mr. Sidney Herbert, our civil Hospitals will ere long engage the attention of some person of sufficient influence to obtain a commission of inquiry with reference to their condition—an inquiry which, if honestly and thoroughly pursued, would disclose a mass of cruel yet remediable evils such as must speedily result in the pulling down and re-construction, on a better model, of a number of buildings long used, in the twilight of sanitary knowledge, as Hospitals, but which are now found to frustrate alike the most skilful efforts of medical science, and the purposes of humanity.

I had intended to touch on the condition of Lying-in

* When remarks are made as to the unhealthiness of an Hospital, at some particular season, the reply usually is that erysipelas is epidemic—that it is found to attack wounds and sores under treatment in private dwellings; but, on inquiry, the dwellings referred to are generally found to be cellars, or the sleeping rooms in back-to-back cottages, where a good sanitary condition of the apartments, supposing surgical cases treated there, is impossible.

† Report of the Commissioners appointed to inquire into the Regulations affecting the Sanitary Condition of the Army, the Organization of Military Hospitals, and the Treatment of the Sick and Wounded, with Evidence and Appendix: printed 1858; folio.

Hospitals—a subject to which recent disclosures concerning their insalubrity have drawn public attention;* but I content myself with a single observation. That a maternity ward, for the reception of certain rare cases in which imminent danger to the woman is apprehended, is desirable, may be conceded; but under ordinary circumstances poor women, I am persuaded, ought to have their confinements at home, since it is well known that the rate of mortality in child-bed, amongst the poor, even in large towns, is extremely small—much less than it is amongst the wealthy classes. An eminent London accoucheur, writing to me in the summer of 1856 with reference to Lying-in Hospitals, declares them to be "a scourge rather than a blessing"—a sentence the justice of which I fear cannot be disputed. I would, therefore, I repeat, supersede Lying-in Hospitals by properly organized and well governed Charities for the delivery of poor women at their own homes.

I am gratified to notice in the Report of the commission before-mentioned—a volume in which is to be found the most valuable body of facts, as to the construction, ventilation, and economy of Hospitals, ever given to the public—that a number of the suggestions in my former Paper re-appear, more or less, in the evidence of several of the most eminent of the witnesses examined, especially in regard to the following points:—

1. *An Hospital atmosphere most effectually prevented by a building constructed in separate pavilions, and every ward occupying an entire storey*: concerning which Miss Nightingale expresses herself thus:—"The best principle of Hospital construction is that of separate pavilions placed side by side, or in line: the former is preferable. It diminishes the distance to traverse from block to block. The distance between the blocks should not be less than double the height. There should not be more than two flats to the block, nor more than one ward to each flat. For the purposes of administration, the building ought to be in a

* I refer to letters concerning the mortality in the General Lying-in Hospital, London, which lately appeared in the *Times*, and in some of the medical periodicals.

square, the ground storey connected all round by an arched corridor, with an open terrace above."*

2. *Natural ventilation the best.*—These are Miss Nightingale's views:—"The doors, windows, and fire-places should be the means of ventilation for such wards as these; nothing else is wanted. If an Hospital must be ventilated artificially it betrays a defect of original construction which no artificial ventilation can compensate; it is an expensive and inefficient means of doing that which can be done cheaply and efficiently by constructing your building so as to admit the open air around. There should be one or more open fire-places in the ward, but lofty, so that the throat of the chimney shall be above the patient's head and bed. Our grandfathers' lofty fire-places are the greatest loss in modern house architecture. The little low fire-places of this date bring the best current of air below the stratum in which we are breathing. With our system, to breathe the best air we must not be more than six years old, or we must lie down."†

3. *The number, position, and height of windows in a ward for the purposes of ventilation and light.*—On these points Miss Nightingale expresses herself as follows:—"One window should be allotted for every two beds; the window to be not less than

* Report, page 380. Much to the same effect is the reply of one of the Commissioners, T. Alexander, Esq. C.B. p. 158. Miss Nightingale's evidence, given in writing, in answer to written questions addressed to her by the Commissioners, and which occupies twenty-eight folio pages of the Report, will be read with profound attention. It well deserves to be printed by itself, and put into general circulation for the benefit of professional men, whether attached to the army or in civil life, but especially for the use of governors of Hospitals, and even for the instruction of architects. I confess I cannot help suspecting that the memorials presented to Lord Panmure in February and May, 1857, by the medical staff of the Middlesex Hospital, respecting the Royal Victoria Hospital at Netley; the debate subsequently on the same subject in the House of Commons; and the printing of the returns with reference to Netley Hospital, have greatly stimulated the Commissioners in the execution of their work, and rendered the report more interesting and instructive.

† Report, page 384. To the same purport essentially is Dr. Sutherland's evidence.—(See page 224.)

four feet eight inches wide, within two or three feet of the floor, so that the patient can see out, and up to the ceiling. Windows are to be placed opposite each other. * * * No part of the ward ought to be dark. This is of the utmost importance in many cases. The light can always be modified for individual patients; but even for such patients to have light in the ward is not the less important."*

4. *Artificial heating of wards injurious.*—In answer to a question as to what is the best system of warming for an Hospital, she replies:—"Radiation; open fire-places." So, too, says Sir J. Liddell:—"I do not think that the hot air ever does—patients cannot endure it, it is so heavy, close, and exhausting."†

A properly constructed, well ventilated Hospital having been provided, we are, in a sense, only at the beginning of our work. Without enlightened administration—in other words, without skilful, vigilant nursing, the sanitary condition of the Hospital will speedily deteriorate, and success in the medical treatment of the sick and wounded be, in a great measure, frustrated. We are yet behind our Continental neighbours in the department of sick nursing. In our Hospitals we devolve the duties properly belonging to the skilled nurse on women, with few exceptions, of the lowest class, and who, it need hardly be said, are uneducated and untrained; whilst, on the Continent, the sick in Hospitals are, and long have been, in the care of educated women who have been trained, and who devote themselves to the duty of nursing from a sense of religion. When in the Hospital at Bordeaux, I remember being struck with the beautiful order that everywhere met the eye. The kitchen, the larder, the vast linen-room, the drug store, the laboratory, the dispensing-room, all in the hands of the sisters, presented a spectacle of neatness and order such as we should in vain look for in any of our Hospitals that I have chanced to visit. I have spoken somewhat disparagingly, perhaps, of the Hospitals in Germany; but I am constrained to

* Pages 381, 382.

† Page 384. See also Dr. Mapleton's objections to warmed air in an Hospital, page 145.

say that I had glimpses—(my visits being so short I dare not call them more)—in several instances of an organization for sick nursing that might deserve our study and imitation. In the Bethanien Hospital at Berlin, I saw some of the Protestant deaconesses, who had more, perhaps, the look and bearing of ladies of station than of nurses. I said to the friend who conducted me, "Do these fine women work? will they put their hand to everything, like an ordinary nurse?" "Yes," he replied, "they wash, they clean, and perform every description of nurses' work." This information naturally made me curious to know more about the Bethanien Sisters, and I accordingly obtained from an eminent physician of that city, Dr. Otto Veit, the following brief account of them. "You must know," writes Dr. Veit, "that the system of nursing in the Bethanien is founded on a religious basis, and that the Sisters are more subject, perhaps, to the Superior, who is a lady of rank, and to the Pastor, than they are to the physician. They do not receive wages, but have their living; and when they become old or incapable of nursing, the House takes care of them. These deaconesses enter at first as probationers for one year, during which they are taught how to nurse the sick and wounded,—the practical part by the elder sisters, the theoretical by the physicians; and, at the same time, they have to perform house work in connection with the kitchen, the laundry, and the like. When, at the end of a year, they are found to be serviceable, they are entered as novices, which means that they have all the rights and duties of the deaconesses, saving that they have not yet a title to the support of the House in case of invalidity. The length of the novitiate is not strictly defined, as it depends upon the will of the Superior, or chief sister, but it is seldom longer than two years; and then the novice takes the rank of sister, or deaconess. The Sisters, I may observe, have the whole administration and service of the Hospital in their hands, and do without the assistance of servants; for they keep clean the sick, make the beds, clean the windows, the rooms, and the water-closets, administer the prescriptions, and,

in a word, do everything for the benefit of the sick, according to the directions of the physician. Every Sister is over one room, with from eight to twelve patients, and near it is her little bed chamber. The night guard is kept by three Sisters, who, for a specified time—usually one month—are excused from service in the day, during which they have their time for sleep. The sisters, I need hardly remark, are under no obligation to remain longer than they choose, and are at liberty to marry. Their number, including probationers and novices, is fifty; and the sick under their care usually number about two hundred and forty."*

On sick nursing, as practised abroad, I will give a brief extract from a letter of my friend Dr. Pincoffs,† Dresden, whose great experience in Hospital service, when civil physician in the East during the war, well qualifies him to speak on this subject. After an interesting sketch of the Protestant deaconesses' institutions in Germany, especially those of the celebrated Pastor Fliedner, of Kaiserswerth, which I regret my limited space will not permit me to present, he thus proceeds:—"In Fliedner's Institutions, the Sisters engage themselves from three to five years; they wear a peculiar costume. In the Institution in Dresden, as in others, they may leave at any time with a short

* In the Bordeaux Hospital, I was told, there were forty-seven Sisters, under a Superior, or head sister, and that the sick in the wards numbered about 550. The admissions annually are about 12,000.

† Dr. Pincoffs, in his work entitled "Experiences of a Civilian in the Eastern Military Hospitals," gives some interesting details concerning the Russian Nursing Sisters, numbering about 88, who, he tells us, were indefatigable in their attentions to the wounded, not alone in the Hospitals, in the ambulances, and in the transports, but also in places close to the batteries where the wounded lay, and where several of these Sisters were hit by the shot. "Their duties" he says, "were strictly defined, and divided into three classes: one class dressed the wounded, another prepared and administered the medicines, and the third attended to the domestic work." No publication on the medical history of the late war surpasses this of Dr. Pincoffs, in the variety and value of the information supplied. With reference to the French medical service, and the organisation of foreign medical schools and Hospitals, the matter given is, I believe, new to the English reader.

notice; they are at the head of the kitchen, laundry, and pharmaceutical departments; and for the latter they have a peculiar apprenticeship to serve. When a patient arrives they see him placed in bed, linen changed, &c.; they attend the *visite* with the doctor; are expected to give him information about the patients, the result of their own observation; to take his orders about food, and to see them executed. Before entering, they must give proof of possessing the necessary qualifications, as reading, writing, knowledge of biblical history, needlework, washing, &c.; and after admission they are taught the actual nursing. The establishment at Bethanien, Berlin, has nothing to do with Fliedner; the lady at the head is a Countess Stolberg, and the establishment is *chiefly* supported by the Royal Family."

It is an ascertained fact that, in all fully peopled countries professing the Christian faith, there are considerably more women than men above twenty years of age; and we may fairly assume that, as this is a law of nature, it is designed to answer beneficent ends in human society.* One of these ends, I doubt not, is sick nursing in Hospitals;—an occupation for which the female sex, when educated and trained, is found to be so well adapted. I fear that in England female philanthropy has not hitherto stepped forth and displayed itself so actively in this particular walk, as it has in some neighbouring countries; but a commencement, I am happy to know, has been made in the work, for several Institutions for the training of nurses exist in London, and are yielding, at the present time, good fruit. As events connected with the late war have given a powerful impulse in the direction referred to, let us hope that educated Englishwomen will, ere long—under a noble guide, whose name it is not even necessary for me to repeat—take a rank not inferior to that of the best of their sisters abroad, in the work of co-operating with medical science to render all our Hospitals—

* See "Thoughts on the Excess of Adult Females in Great Britain, with reference to its causes and consequences,"—a Paper read before this Society in 1840, and subsequently published in the Edinburgh Medical and Surgical Journal, vol. 54.

what I am afraid I dare not at present pronounce them to be—asylums for the *cure* of the sick and wounded.

By the courtesy of a Committee of gentlemen at Blackburn, formed for the purpose of erecting an Infirmary there, I am favoured with a sketch of the first floor of the projected building, and also with permission to have it lithographed for our Transactions. The site selected for the Infirmary is, I learn, more than eight acres in extent, well elevated, so as to have good natural drainage, situated on the windward or south-west side of the town, and distant from it about half a mile. The structure is to consist of separate blocks, two floors in height, placed alternately at intervals of twenty feet, on opposite sides of a lofty corridor ten feet wide, running the entire length of the range, and opening at either extremity to gardens. By this arrangement a series of quadrangles is obtained, each sixty-five feet wide, and having twenty feet of well lighted and well ventilated corridor space on either side of a block. The blocks, extending forty-seven feet at right angles to the corridor, contain on each floor a ward of eight beds, and a room to be described presently. The ward, entered from the corridor, is thirty-nine feet in length, twenty-three in breadth, and sixteen feet high, giving a cubic-air space for each bed of 1,794 feet. The windows are five on either side, and reach to near the ceiling; whilst between the top of the window and the ceiling is a finely-perforated zinc plate communicating with the external air. At each end of the ward there is a fire-place having an opening five feet in height. On either side the fire-place farthest from the corridor are the scullery and bath-room, and beyond these, at the extremity of the floor, is the latrine. This, entered by two doors, an outer and inner, is of the same height as the ward, has through ventilation flowing at right angles with the door, and water-closets that are self-acting. In the scullery is a discharging shaft, by means of which fouled linen, fouled bandages, and the like, are passed at once to the basement.

The beds, the architect informs me, are to be of iron, on wheels six inches in diameter, by which contrivance the beds can be moved, when necessary, into the corridor. The flooring of the ward will be of Norwegian pine, waxed and polished; and the walls and ceilings are to be finished with Parian cement. Across the corridor, opposite each ward, is a room twenty-three feet by fourteen feet. One of these rooms on the male, and one on the female side—with two beds in each, and having a cubic air space of 2,576 feet per bed—are appropriated for special cases, such as severe sickness or accidents happening to domestic servants, and casualties in which separation from the sick ward is judged advisable. The remaining two rooms on either side supply a dining-room for convalescents, and a reading-room. Besides the well-aired corridor—divided at the centre by a barrier to separate males from females—in which convalescents may walk, there are the balconies; and also, opening from the corridor on either side the chapel, terraces, each twenty feet by fourteen feet, furnished with seats.

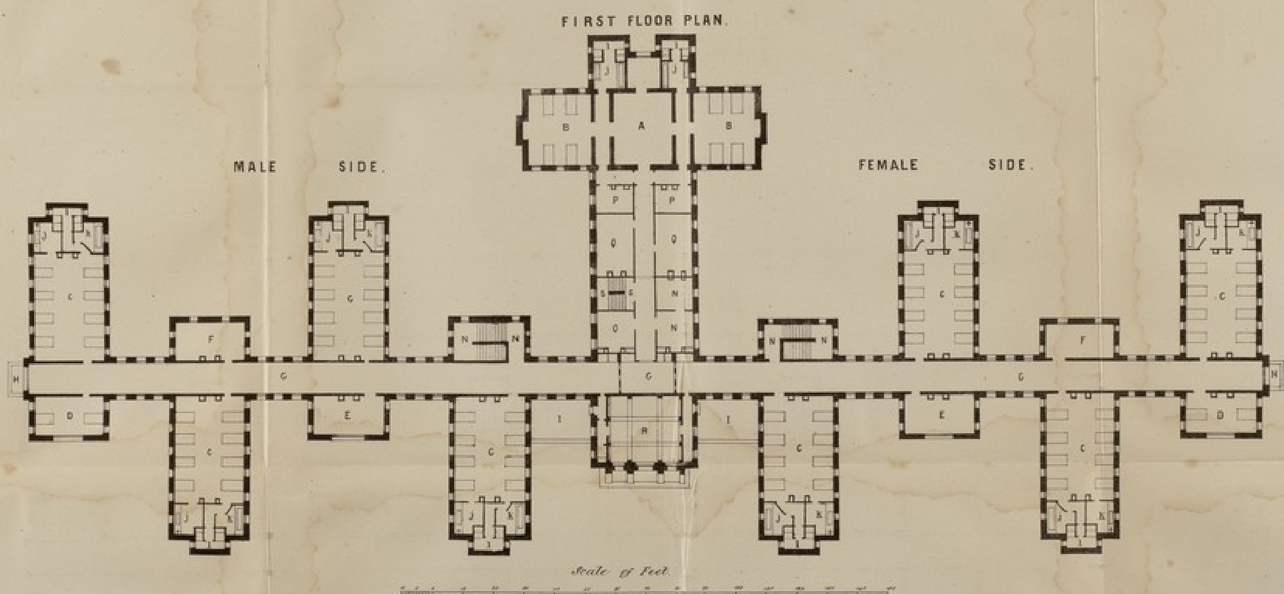
In the centre is the principal block, 32 feet wide, in which, besides the chapel and terraces, may be discerned the nurses' kitchen and other nurses' rooms; the operating-room, and the wards after operations; the latter containing eight beds, with a cubic-air space per bed of 2,044 feet. The architect informs me that he provides no artificial warming for the wards besides fire-places with ample openings, and that for summer, when fires are disused, there is to be a gas jet opening above the chimney-piece within the flue, by means of which he will ensure, even in the hottest season, an up-draught, and so maintain the purity of the air in the ward. I might, with the assistance of the architect, give a description of what is to be found on the ground storey, and in the basement, as well as in the attics; but as this would lead me into a minuteness of detail foreign to my present object, I forbear to do so. The sketch, incomplete though it be as affording only a view of the arrangements on one of the floors, will, I have little doubt, be studied with interest, especially at the present time, when the state of

Military Hospitals is exciting so much discussion, and, of course, is arousing many to inquire as to what may be the sanitary condition of our civil Hospitals. It is, perhaps, necessary for me to say that the Committee do not contemplate carrying out the whole of the design at once; and that the sketch shews what the first floor of the Infirmary is to be when completed—an event which will, probably, happen in the course of a few years hence.

EXPLANATION OF THE ACCOMPANYING PLAN OF THE INTENDED HOSPITAL AT BLACKBURN.

A. Operating Room.
B. Wards after Operations (male).
C. Sick Wards.
D. Rooms for Special cases.
E. Dining Rooms for Convalescents.
F. Reading Rooms.
G. General Corridor.
H. Balconies.
I. Terraces, where Patients may take the air.
j. Ward Scullery.
k. Bath Room.
l. Latrine.
+ Discharging Shaft in Scullery.
N. Nurses' Sitting and Bed Rooms.
O. Nurses' Kitchen.
P. Nurses' Rooms in connexion with Operation Wards.
Q. Nurses' Dormitories.
R. Chapel.
S. Staircase from basement to domestic Dormitories.

Professor E. A. Parkes
&c &c



PROSPECTIVE PLAN OF INTENDED INFIRMARY BLACKBURN

Geo. Harrison Lith.

Jas. Turnbull Archt.
Manchester.

Professor E. A. Parkes
&c &c
Army Medical
Netley
with the Author's
Compts

ON SOME UNSOLVED PROBLEMS

IN RELATION TO

PUBLIC HEALTH.

BY

WILLIAM ROBERT CORNISH,

ASST. SURGEON MADRAS MEDICAL ESTABLISHMENT,

SECRETARY TO THE PRINCIPAL INSPECTOR GENERAL MEDICAL DEPARTMENT.

No. I.

THE CLEANSING OF TOWNS.

MADRAS:

GANTZ BROTHERS,

ADELPHI PRESS, 175, MOUNT ROAD.

1864.

INTRODUCTION.

For some years past I have had it in contemplation to write a "*Manual of Hygiene*," suitable for India, using as the basis of the work the accumulated records of the Medical Department of the last eighty or ninety years, but, like the majority of the servants of the State, I have had but little leisure for literary work of a nature not strictly pertaining to my immediate duties.

To await an anticipated leisure would be to postpone indefinitely the commencement of the project I have had at heart, and I prefer to publish, though in an incomplete form, the opinions I hold in regard to certain, as yet unsettled, questions bearing upon public health, rather than await the more convenient season that may never come.

A new and important era in State Medicine, has just begun for India. The sanitary condition of the Army, and of the people generally, is attracting a degree of attention never at any previous time accorded to such subjects, and the recent appointment of our Presidency Sanitary Commissions is an earnest, that questions of Public Health are henceforward to be systematically considered in relation to the moral and material progress of the people. To aid in popularising the scientific knowledge we already possess in regard to certain matters

affecting the sanitary condition of the people, I propose to issue, from time to time, a series of pamphlets explanatory of the leading principles which should be embodied in a Code of sanitary rules, for India. I hold that many of the questions must be considered, not in a slavish spirit of imitation of what has been done in European countries, but simply *ab initio* in regard to their fitness to the peculiarities of a tropical climate. If I venture to differ from the conclusions of eminent Sanitarians in other countries, I trust to be able to show that I have good grounds for arriving at the views I attempt to enunciate.

The regularity of the publication of these sanitary tracts will depend, as all such undertakings must necessarily do in India, upon health, strength, and leisure being given me, to complete them in such a form, that the subjects may be understood by the general reader.

The Indian Sanitary Commissions are empowered to frame a Sanitary Code for the several Presidencies, and the work entered upon under such favorable auspices, will naturally be more perfect than any single individual could hope to make it, even if he gave the best years of his life to an undertaking of which it is scarcely possible now to see the limit. In the present series of "tracts," I purpose entering only upon the consideration of subjects which are either imperfectly understood, or about which there are diverse views entertained.

It is intended that the series shall include a notice of the following subjects :—

No. 1. The cleansing of Towns.

2. The influences of soil, and Geological features of a locality upon public health.

3. Registration of Births, Deaths, and Population Statistics.

No. 4. The influence of Rice cultivation in the production of malaria, with an examination of the evidence upon which the theory of the noxiousness of irrigated lands is based.

5. On the use and abuse of nervine stimulants.

6. "The social evil," and an examination of the evidence for and against the establishment in India, of Lock Hospitals.

W. R. C.

MADRAS,
4th May, 1864.

ON THE CLEANSING OF TOWNS.

"IT is good not to try experiments in States, except the necessity be urgent, or the utility evident; and well to beware that it be the reformation that draweth on the change, and not the desire of change that pretendeth the reformation."—BACON *on Innovations.*

IN India we have heard a great deal lately about "Dry" as opposed to the European system of "Wet" Conservancy, or "sewerage." The systems are so thoroughly opposed in principle and practice, that it seems necessary in the introduction of the subject, to explain why the one may be best suited for countries where water is scarce, and the other easy and economical of application in lands where the water supply is unfailing.

The principle upon which dry conservancy has been so strongly advocated in India, though nowhere distinctly put into words, appears to be founded upon the well-known fact that moisture is essential to putrefaction, that if there be no moisture present there can be no chemical change in the elements of organic matter. It is well understood that to mix organic substances with water in a hot climate, is simply to anticipate Nature in the creation of foul odours arising from the putrefactive process, and that the most cleanly way of removing excrements is by depriving them as far as practicable of their moisture, and thus retarding their decomposition, and consequent evolution of noisome gases to pollute the atmosphere.

The effects of dry air, or of substances capable of absorbing moisture, upon animal or vegetable matters, have long been known in a practical way, though the scientific application of the knowledge to conservancy purposes is of very recent origin. The Red Indians and hunters of the far west, when about to take an excursion across the prairies, supply themselves with dried buffalo flesh, as provender for the journey. The meat is simply cut into long, thin strips, and deprived of its moisture by exposure to a dry, and pure air; in this condition it will keep for weeks or months, retaining all its powers of nourishment, and undergoing no putrefactive change whatever. This is about the best instance that could be adduced of the value of "dry conservation" of organic matter. Supposing, however, that instead of carrying provisions in a dry and portable form, a party of emigrants, ignorant of the ways of the country, had attempted to boil down their buffalo meat into concentrated soup to last them upon their journey. What would have been the results? In two or three days the whole stock of food would have become putrid, and the people, supposing them to have had nothing else to fall back upon, would have died of starvation. In England, people would never think of preserving their meat as they do in Western America. In fact if they tried ever so hard to accomplish it, without artificial heat they would fail, for the conditions of the atmosphere in the two countries differ widely. In the one it is quite practicable, in the other just the reverse. The question will therefore come up by and bye, whether, if the relation between the conditions of climate and the putrefaction of organic substances is so different in the two countries, the means to be employed in the cleansing of towns should not also vary according to climatic conditions?

The exporters of provisions have for some years past recognised the importance of the fact, that for decomposition to take place there must be moisture present. They find that in driving off, by artificial heat, all the watery particles of milk potatoes, or green vegetables, these substances can be exported with ease to any part of the world, retaining for years their full nourishing powers, and requiring only the addition of the

water of which they had been deprived, to make them palatable and useful articles of food.

So the Farmer, who wishes to turn the rich and juicy grass of his meadows into dry and portable food, for the support of his cattle during the depth of winter when all vegetation is at a stand-still, proceeds upon the principle of "dry" conservation. He does not, after the manner of the advocates of "wet" sewage, deluge his cut grass with water, and then leave it to ferment and putrify, until it has lost all its nourishing properties, but he carefully spreads it in the sun, takes every possible precaution to keep water from touching it, and when all its moisture has been drunk up by the dry summer air, proceed to stack it carefully away for future use.

Now, the arguments which apply to the preservation from decay of organic substances used as food for man and beast, apply with equal force to those substances after they have served for the nutrition of animals. The excretions of animals contain all the elements of the substances which are used as food. They can be preserved without decomposition by deprivation of their moisture, and can, in a dry state, be conveyed to any part of the world where they may be wanted to fertilise the soil. The practice is not unknown in Eastern countries, although its true principles are not understood. The natives of India are familiar enough with the method of drying the solid excrement of cattle with the double object of preventing decomposition and of making it more portable as fuel. The manufacture of "bratties" is strictly a process of "dry" conservancy, so far as the removal of effete matters from human habitations is concerned, though the use of these substances in lieu of firewood is opposed to every true principle of scientific farming. The Chinese know better the value of animal manures and are practically familiar with the fact that the deprivation of their moisture preserves their fertilising properties, and renders them portable. The manure factories in the outskirts of

Chinese towns, where human excrement is dried in cakes for transmission to the inland districts, need only to be instanced, in proof of the practical intelligence of a people who have been described as the best farmers and gardeners in the world.

A model system of "dry" conservancy, then, should aim at two things:—

1st. The deprivation of the substance to be conserved, of its natural moisture, with the view of suspending putrefaction and waste.

2nd. The restoration to the soil of the animal excretions, with their fertilising properties unimpaired.

Such a scheme, in regard to the refuse of towns and barracks in India, has never yet had a fair trial. That spoken of as the "Punjaub system,"* merely aims at the removal of excrement, but takes no account of the importance of preventing its decomposition and waste after carrying it to the "deep pits" outside the town or cantonment.

The "dry" system hitherto in vogue in India, involves only a partial application of the true principles by which it can be made thoroughly effective. Bad "dry" conservancy, or a badly arranged system of sewerage, are infinitely worse evils than those resulting from leaving the filth of towns to be disposed of by "Nature's scavengers."

There is no doubt that the "dry" system of conservancy, is the best that could be devised for a country where the temperature of the air is always high; the putrefactive process in decaying organic matters unusually rapid; the water supply scanty, and requiring to be raised from *below* the surface, and the fall of the country insufficient to give a free natural outlet for liquid sewage.

Where these conditions are found united it will not only be more economical, but more conducive to the public health, that the excrementitious matters of the population should be

* See Appendix I.

conveyed away to the open fields for use as manure, than allowed to flow into drains, to putrefy and taint the air, water, and soil, of crowded communities. In the cities of Europe, where the water supply is derived from ever-flowing springs, it has been thought an economical measure to remove excreta from dwelling houses by a flow of water, the whole refuse ultimately finding its way into running or tidal streams, and so out to sea. But this plan was devised as a temporary expedient for the cleansing of towns, long before the attention of scientific men was directed to the enormous waste of valuable manure which would follow its general application. The evils of the sewage system in Europe are now gradually becoming evident, and in another quarter of a century there is no question but that the nuisance will have become so serious, as to lead to a thorough change of system. The rivers flowing through towns are in many instances already so polluted, that fish will not live in them, nor can the public drink of such water with impunity. The refuse which ought to have gone to enrich the land is swept out uselessly to sea, until the agriculturists are crying out that the soil is exhausted of its "phosphates," and are spending millions of pounds sterling every year in guano and artificial manures to repair the waste.

These are the more marked of the evils attendant upon the drainage of towns; the advantages of the sewerage system are, that the refuse is disposed of without offence to the senses of sight or smell, and *cheaply*, so far as the mere removal is concerned. The prevention of nuisance is, however, chiefly due to the fact that, in the cooler regions of the earth, the *temperature* of the water which is mixed with the excreta, being generally lower than that of the air, rather *retards* than hastens the putrefactive changes in human excrement and urine.

The water closets, house drains, and sewers, in European towns, it may be noticed, remain inoffensive during the months of spring and winter, but as the temperature of the air increases, so surely do the *cloacæ* begin to emit offensive effluvia, and the hotter the summer and autumn, the greater the nuisance from drains and running streams polluted by sewage. Whenever the temperature of water rises above 60° Fah: it ceases to absorb gases well, and becomes therefore a bad vehicle for the removal of organic matter in a state of decomposition.

In tropical countries the putrefactive process, *when water is present*, proceeds with a truly wonderful rapidity. Not only do animal excretions decompose with great speed, generating poisonous compounds to pollute the atmosphere, but common house-sweepings, cook-room refuse, &c., when mixed with water, become in a very short time an intolerable nuisance. Even the waste water from bath-rooms, if retained for a few hours in a cesspool or reservoir, will be almost as offensive as excrementitious matters themselves.

These facts, which are patent to everybody in India, are systematically overlooked by professional Engineers and Sanitarians at home, who, from time to time, have put forth their views regarding the drainage of Indian towns and cantonments. It seems to be imagined, as a matter of course, that any amount of water-power can be turned on, and that sewage can be got rid of in India as elsewhere, by constructing sewers to discharge their contents into running streams. Witness, for instance, the recommendations of the Royal Sanitary Commissioners for India, in regard to drains, water closets, and urinals. The "dry" method is wholly ignored, the Commissioners apparently being unaware that the practice or system was anything more than a relic of barbarism, or of the crass ignorance of Indian officials in regard to modern sanitation.

The truth is, that even if a thorough system of drainage, as in

European countries, were advisable, the practical application of the principle would be attended, in the Peninsula of India, by difficulties insurmountable.

Let anybody who seriously considers the question, just think—first, where the water to flush sewers is to come from, and, secondly, where the sewage is to go to, after it leaves the crowded community. Let him reflect upon the fact that the great tract of country sloping away from the mountain ridge—the "back bone" of India—to the Coromandel Coast, and whose rivers flow eastward, is natually so arid, that for months together the streams which take their rise in the western ghauts, and empty their storm waters into the Bay of Bengal, are nothing more than wilds of sandy waste, with perhaps a tiny stream meandering through the middle. The river beds are visible, and water may be found at varying depths below the surface, but the precious fluid is not available in quantities for drainage purposes, except at a cost wholly beyond its value. But, even supposing that water could be stored for a system of sewerage in native towns inland, where is the sewage to flow to? The great rivers, the Godavery, the Kistna, and the Cauvery, which contain more or less water throughout the year, do not run near to many populous towns, and are practically unavailable for the purpose. Along the Coast, sewage might probably be pumped into the sea, but the difficulty would still remain with inland towns, such as Bangalore and Secunderabad. We might, it is true, in some of these stations, do as is done at Poona, turn the filth of a large city into a stagnant "pool," devised for supplying the inhabitants with drinking water, but with the experience of that city before us, it is doubtful whether such an arrangement would be conducive to an improvement in public health. At Secunderabad and Bangalore the storing of water for sewage, from the nature of the surrounding country, is believed to be impracticable.

There are, in fact, no streams conveniently situated to our towns in the Peninsula of India, with a constant flow of water to dilute and carry away liquid filth. The sewage would simply sink into the soil by the mouth of the outlet sewer, and become a source of evil in another place. India, for many months of the year, is a dry and a thirsty land, so greedy of moisture, that unless sewers be built of some less absorbent material than brick and mortar, the soil will take up all the watery parts of the sewage, leaving the solids to choke up the artificial channels. This state of things obtains in the town of Madras throughout the hot and dry seasons, and it is no wonder that, under such circumstances, the odour of our drains should have obtained a proverbially evil repute. Mr. Strachey,* in his late Minute on the sanitary condition of Calcutta, with its underground sewers, has declared it to be the most filthy of the filthy cities of the world, while of Madras it has been averred by competent authority,† that before the construction of drains, its abominations were not so noticeable as they have since become. The attempts hitherto made to follow in Indian towns the European model of sewerage, have undoubtedly had the effect of making those towns more pestiferous than they were before sewers were thought of.

The system of conservancy, first regularly laid down upon sound principles by Dr. Hathaway, and now officially ordered to be adopted in the military stations of the Bengal Presidency, is I consider still defective in details. The main purpose has been to get rid of the refuse at any cost, and the idea of utilising it, in adding to the reproductive powers of the soil, has not apparently been at all considered or has been a subject of only secondary thought. The object was to convey away the solid and fluid excreta day by day, and to bury

* See Appendix II.
† Mr. Cole in "Report on Causes of Death in Madras," 1860.

the same in deep pits. No doubt, where the system has been properly worked, it has succeeded in doing away with what was formerly a fertile source of disease to the living, but it has been effected at, comparatively speaking, an immense cost, while considerable tracts of land which might have attained more than double their present value had they been manured, have remained from year to year in a state of chronic impoverishment.

There are, no doubt, certain prejudices amongst the natives with regard to the use of animal manures, but many of these must be looked upon as simply the result of ignorance, or of habit and custom. Natives are not above learning and following good examples, when they see with their own eyes the superiority of many of our modern appliances of civilization over their own rude and clumsy contrivances, and the value and importance of the refuse of towns to the agriculturist, will doubtless be appreciated when its utility has been demonstrated to them. If, as the Hon'ble T. Pycroft avers, the natives of India are no more prejudiced in favor of old fashions in farming, than are the "chaw bacons" of Somersetshire, the value of human excrement will in time be better understood, for there is reason to believe that the present race of farmers in that county are wide awake enough to their own interests.

We further know that by every principle of right and scientific teaching, we cannot afford to throw anything in the shape of organic refuse away: that in the great laboratory of Nature nothing is ultimately lost, or wasted, though by our mismanagement we may and do divert things of direct utility into channels of indirect waste. It is not a mere figure of speech to say that by the modern system of sewerage in Great Britain, we squander millions of pounds worth of manure by allowing it to run out uselessly into the ocean.

The commercial value, according to Dr. Thudichum, of the nitrogenous compounds, which are excreted from the human body, is not less than *ten shillings per head per annum* of the population—that is, if the whole of the urea and ammonia and phosphates of the urine and fæces could be collected, the farmers who buy guano and artificial manures solely on account of their containing these principles, would gladly pay at this rate for the concentrated product.

In India especially, it seems desirable that an effort should be made to enrich the soil, simultaneously with the introduction of measures for the improvement of the sanitary condition of the people. In all countries, the consideration of these subjects should be taken up together, but here where the State Revenue is so much influenced by agricultural prosperity the combination is particularly wanted, the surface soil being in great part exhausted, and the public health most seriously influenced by neglected conservancy. This is scarcely the place to adduce proof that the surface soil in many parts of India is already worn out under the continual cropping it undergoes, and the neglect to return to it the matters which are taken away year after year in the crops. There can be no doubt that many of the products of India might be much improved in quantity and quality, by deeper ploughing and manuring of the land. The bad results of using animal manures for fuel, have been forcibly noticed by His Excellency Sir W. Denison in a most valuable Minute upon labour and machinery, as applied to agriculture.

Bearing in mind all the difficulties in the way of carrying out a system of dry conservancy, I have attempted to design a latrine and urinal suitable for the use of natives at Railway stations or in the midst of populous towns, and in which the "dry" system can be brought into operation without offence to anybody, while the whole of the products,

fluid and solid, can be made immediately available for the use of the agriculturist.

A model system of "dry" conservancy, as before stated, should aim at the removal of the solid and liquid excretions of the body to the soil to be manured, without putrefactive change or admixture with water, or anything else tending to produce fermentation or decomposition. The customs of the people of India are (in dry weather) unwittingly on their part, a clumsy attempt at "dry" conservancy. By resorting to the fields, the feces being exposed to sun and wind, soon lose their moisture, and become *mummified*, retaining however all their fertilising properties, while the urine voided upon a dry soil is absorbed without offence. But this state of things only lasts so long as the air is dry and hot; a slight shower of rain, or heavy dew, being sufficient to set up the fermentative process, which makes the out-skirts of all our large villages so disgusting to the sense of smell. It is obvious, therefore, that in the carrying out of any system of "dry" conservancy, it is absolutely necessary that the *place d'aisance* should be covered in, so that the excretions may not be exposed to the periodical rains, nor to the heavy dews, which rest upon the surface of the earth in the cold season of the year.

To assist in the drying of the feces, and to preserve the purity of the air within the latrine, it is necessary that while sheltered from rain or moisture, the interior of the building should be open to free perflation, besides being capable of thorough ventilation. In this respect the place designed for the purpose should have the walls dwarfed, so as to allow of open spaces between the roof and the wall.

It should be borne in mind, that feces do not putrefy readily in a dry, hot air. If they be further enveloped in dry earth, wood ashes, or charcoal, the desiccating process is hastened, and there is less risk of any putrefaction taking place.*

The subject of separately collecting the two great excretions of the body, has been considered by some eminent men in Europe, with the view of more thoroughly utilising the products for agricultural purposes.† Various means have been proposed to this end, but they do not appear to have found general favor in a country which has committed itself to a system of wet conservancy. The difficulty, however, in separating the fluid and solid excrements, especially with a race of people who cannot be persuaded to sit upon an artificial contrivance, is not so great as may at first sight be supposed.

It is calculated by physiologists, that of the total amount of urine excreted, at the least five-sixths are voided independently of any action of the bowels. Urine is much more valuable as manure than feces, on account of the large proportion of urea and phosphoric acid it contains. With this five-sixths of the urine then, there is literally no difficulty at all in the separation from the solids; all that is required for the purpose being a urinal away, or distinct from the place of resort, for the voiding of feces. In regard to the arrangements for the separation of the fluid and solid excreta, it seems to have scarcely attracted any attention, until Dr. Thudichum drew attention to it, that Nature has already provided the means, by the peculiar arrangement of the outlets of the urinary and intestinal canals; the urine being propelled forward at a considerable angle, and the feces in an opposite direction backwards. The following simple diagram gives a fair idea of the natural direction of the urinary and fecal canals, during the act of defecation.

* I see that the Prison Committee in Bengal object to the use of wood ashes. The objection is valid, when applied to mixture of urine and feces, but not to *feces alone* as I propose. Wood ashes are even better than earth for this propose as the alkali neutralises the acid properties of the feces which earth does not.

† See Appendix iii.

It will be evident, therefore, that for a class of people who, exercising an insuperable objection to sit upon any contrivance provided for their use, prefer to squat on the ground, it is not only possible, but quite practicable to collect their excretions separately, and without admixture.

This point has been apparently lost sight of in the Bengal standard plan, and is, I think, the weakest part of Dr. Hathaway's system, admirable as it is in most other respects. But, in fact, it is really the most important thing to be considered in a scientific arrangement for carrying out a thorough "dry" conservancy for natives. In the one case it means cleanliness, decency, and comfort, with efficient conservancy, and in the other, dirt, and evil smells continually, so that the people are prevented from utilising the excretions as manure. It is a curious fact, that urine and feces when mixed together, exert a mutual action or ferment tending to decomposition, but if carefully separated, the decomposition may, for a time, be retarded.

In the accompanying plan of a latrine designed as before said chiefly with the view of providing accommodation for natives at Railway stations, or in the midst of crowded cities, this principle of *complete separation* of the fluid from the solid excreta has been kept in view, and in the case of natives, I have no doubt whatever of its being managed, after a little preliminary care and trouble, with complete success. The utilisation of the excretions as well as their cleanly removal, has throughout been the idea I have attempted to realise. It would seem that if the present native practices are to be improved upon, the people must be taught to understand that it is to their own interests that the fluid and solid refuse of the latrines should be conveyed away separately as valuable manures, instead of in the shape of decomposed and almost worthless rubbish.

Practically, the liquid sewage system in Europe has failed as regards its use to the agriculturist, for the simple reason that the more valuable portions of the sewage have been decomposed and dissipated in the form of highly poisonous and offensive gases, leaving only the more stable and worthless constituents remaining in the mixed fluid of the drains. The farmers who expected in the sewage laid on to their grounds perpetual streams of fluid guano, have been chagrined to find that the ammonia has flown away, and the phosphoric compounds have dissolved into thin air, leaving nothing but a fetid fluid behind, no more fertilising in its properties than ordinary river water.

Our present dry conservancy practice in India is very little, if at all better than the modern drainage system, as regards the employment of our refuse in increasing the fertility of the soil. Five-sixths of the urine, the most valuable of all animal manures, is utterly wasted, and of the feces and urine carted away to a distance, we have not yet succeeded in getting the natives to regard these animal products as of commercial value. It is buried in deep pits, to be out of harm's way, which pits it is needless to say, are expensive to construct, and in many cases a nuisance to public health, from the concentration of so large an amount of animal matter in a stage of decomposition. In Madras however a European gentleman has I believe found it a paying concern to contract for the removal of the contents of barrack privies, to his grass lands in the outskirts of the town. By constant manuring and irrigation very heavy crops of hay are produced throughout the year.

In the practical consideration of these things, we have

been losing sight of the fact, long known, that the earth is the natural absorber and deodoriser of organic matter in a state of change or decay. Charcoal, well-dried and powdered, is known to have the effect of absorbing and deodorising an almost incredible quantity of offensive gas or foul air. There are several other agents which arrest, or keep back, putrefaction in decaying animal matter. One of these is *pure cold water*. In India although we may succeed, with difficulty, in getting a plentiful supply of water, we cannot get the *low temperature* which is essential to a system of "wet" conservancy. Water above 60° is sure to hasten the decomposition of organic matter. Earth, particularly of clayey or alluvial soils, well and thoroughly dried in the sun, and finely powdered, is known to have a wonderful effect as a deodoriser, and the fact has been lately turned to practical account in England and elsewhere, in the attempt to supersede the present drainage system, by what is called "earth sewage," *i. e.*, the reception of the excretions of the body upon dry earth, which is subsequently carted away and ploughed into the fields, without any nuisance whatever. About one or two handsfull of well-dried earth is sufficient to deodorise and solidify one evacuation. To effect a thorough commixture of the earth and excretions, "earth closets" have been invented, and are already in use in many places.

In July of last year the attention of the Indian public was drawn to this important improvement in the practical details of a dry conservancy, and in the columns of the *Madras Athenæum and Statesman** reference was pointedly made to the papers read before the *Society of Arts* in May of 1863, by Dr. Thudichum and Rev. H. Moule. The latter paper I regard as an almost complete solution of the practical difficulty of establishing an efficient "dry" conservancy for Indian towns and Military Stations, and

* See Appendix No. iv.

I have printed it almost entire in the Appendix,* for easy reference.

For natives of India it is essential that the modification of the "earth sewage," and "separation of fluid and solid" systems, such as I propose, should be on the simplest possible plan, and I have tried in my design to combine simplicity with efficiency. The ground plan and elevation of the latrine, will make clear to the reader the proposed arrangements.

One side of the building is for males, and the other for females, twenty of each might be accommodated at one time in the privy. The urine, voided into a channel against one wall of the building drains along an asphalted gutter, (the whole of the interior, floor and walls is to be asphalted,) and after being filtered through a movable screen containing coarsely powdered charcoal, is finally received into an asphalted reservoir outside, which reservoir is to be nearly filled every day with dry earth, to allow of the urine being absorbed and subsequently carted away without decomposition or offence. The object of the filtration through charcoal is to remove the mucus of the urine, by which arrangement it will not begin to decompose for a period of twenty-four hours or more.

In the privies, the following arrangement is suggested. In the space allotted to each person the toty will keep a flat, saucer-shaped chatty painted or soaked in coal tar, and well dried previous to use, to receive the solid excrement. These chatties should always contain a little dry earth or wood ashes, and after use the evacuation should be immediately covered with a small quantity of *wood ashes,* kept in readiness for the purpose within the enclosure, and the whole removed to the shed outside, where the chatty should be emptied, and the mixed ashes and fecal matter put into an iron tub or basket for removal. It will be observed in the plan, that separate provision is made for the reception of the urine passed during

* See Appendix No. v.

defecation, in an asphalted channel, which conveys it to the urine reservoir outside.

In the Madras Eye Infirmary, my friend Dr. George Smith has lately adopted a plan of ordering the toty on duty to provide a tarred, flat chatty to each person as he goes into the privy, and to receive the same at the door with contents from the person going out. This saves much time, and enables the attendant to wait upon a number of persons at once, but it is doubtful whether it could be adopted with the mixed classes of people frequenting public latrines.

The object in applying wood ashes to the feces is to absorb moisture, and to neutralise the acid properties which cause them to ferment. The ashes *should never be allowed to touch the urine,* because of the alkali they contain tending to decompose the urea and to set free offensive ammoniacal gases. It must be remembered that *acid in urine* keeps it from decomposition, while *acid in feces* helps the process of putrefaction. For the same reason that the alkali of the wood ash should not be permitted to touch the urine, the walls and floor of the building throughout have been designed to be covered with asphalte, or some bituminous compound, so that not a particle of the lime or brick work of the building should come in contact with either urine or feces.

In the plan, no arrangement has been specified for the people washing themselves after defecation. There is a difficulty in knowing how to arrange for a water supply to latrines. The best thing probably would be enamelled iron bidets, two or three on each side fixed against the wall, with a small stream of fresh water flowing through them. The native habit is I believe almost invariably to use water after defecation, but the water should be so arranged as not to lead into the urine reservoirs. I would prefer however a small running stream fed from a cistern, or a bathing tank *outside* the latrine, but concealed from public observation, to which the people might resort for this purpose, as there are practical objections to bringing any water within the privy itself. It would be impossible to keep the splashings from mixing with urine and feces, and a "dry" conservancy would be impracticable.

As regards the supply of earth for the reservoirs to receive the urine, it would have to be changed once in twenty-four hours, oftener if thoroughly saturated with urine, spread out in a shed and thoroughly dried and sifted, when the finer parts would do to use over and over again. After some three or four saturations and dryings, it would have absorbed enough of the urinary salts to make a really valuable manure, which, when the people shall have once learnt its value, will sell for enough to nearly pay the whole cost of the conservancy establishment. A great deal of waste land has lately been taken up by speculators in the neighbourhood of the canals and about Madras, and there is not a doubt that concentrated manure of this kind will by and bye find a ready sale.

The feces on the other hand, in a dry and portable form, mixed only with a little earth or wood ash, would be quickly bought up by the market gardeners and owners of land in the immediate neighbourhood.

In the earth sewage system, the great secret is to use the soil *perfectly* dry; the more it is dried, the more will it absorb fluids and gases, and retard putrefaction.

In wet weather, a supply of dried earth should be kept ready prepared *under cover*. In a little time contractors would probably come forward to engage to bring the earth ready prepared into the town, on condition of being allowed to take it back again to their fields and gardens after being improved by the animal deposits.

The advantages of the plan briefly sketched, appear to be:

1st. Freedom from all nuisance. With proper management

there could be no objection to the setting up of one of these latrines in the most crowded part of a native city.

2nd. Utilisation of the whole of the refuse, and its application to the improvement of the land.

3rd. The principles here laid down might be applied in private establishments, especially where there is a garden or compound, much to the improvement of the produce, grass, vegetables, &c., and to the comfort and salubrity of the parties concerned.

4th. Public urinals distinct from privies, can be set up in the most convenient situations, and arranged upon this system, and the whole of the fluid excretion thus saved for restoration to the soil.

5th. The greatest advantage of all would be the doing away with the necessity for costly drainage works, which it is thought will never be of any use in keeping the town clean of ordure, for the simple reason that natives *will not sit upon, or use water closets.* A hundred years hence perhaps they may have got over their prejudices in this respect, and then it will be time enough to think of providing hydraulic power for the removal of town refuse.

To work a latrine and urinal such as has been briefly described, if in a populous neighbourhood, there would be required two toties constantly on duty, say from 4 A. M. to 10 P. M., and this would necessitate the employment of four persons—two males and two females. The entrances would have to be lighted at night, and the Police required to see that no improper use was made of the building.

As for the kind of earth to be used, nothing could be better than the *dust* of our laterite roads in Madras, or dried clay, which might be collected, prepared and stored in a shed, not too far away from the latrine, and the same might be arranged with regard to the wood ashes, which are now taken away every morning from the public streets by the scavengers' carts. With a little arrangement, it would be possible to employ the carts for bringing earth and ashes, and taking them away again when saturated, to some central manure depôt, which the Municipal authorities would find it necessary to establish, for the sale of the valuable refuse of the city.

As to the value of the manure so collected, it must be borne in mind, that the urinary excretion of any one person during 24 hours is worth, at the least *four times* as much as the feces passed in the same period.

Becquerel's analysis of many samples of urine gave an average of water, 968· 815 parts, of solid constituents 31·185. The analyses of some later chemists, have raised the quantity of solid constituents to from five to seven per cent. Now in regard to this fluid, the only difficulty in converting it into a portable manure is in getting rid of the water, amounting to upwards of ninety per cent. of the whole. As a temporary expedient, its absorption and dryage by means of *Earth* is proposed, but in a country where salt is manufactured on a grand scale out of sea water, by simple evaporation, I do not despair of seeing measures adopted to concentrate urine for the farmer's use without the intervention of any drying material. The addition of one of the mineral acids would probably prevent any decomposition or waste of the nitrogenous compounds it is so essential to preserve unchanged.

Healthy human feces according to Berzelius contain

Water	73· 3 parts.
Solid residue of vegetable and animal remains, salts, and extractive matter.	2·6 7.

But although the proportion of solid matter is larger in feces than in urine, it is less valuable as manure. It contains but a very small proportion of the nitrogenous compounds

which make the excretions of animals so useful in restoring fertility to the fields.

In any system of "dry" conservancy, the removal of the urine is quite as necessary as that of the feces. Public urinals, designed upon some modification of the plan here sketched would allow of a very large proportion of this excretion being saved.

The cost of the proposed latrine, some two thousand Rupees, is no doubt an objection. But it might be constructed of cheaper materials. Dr. Hathaway has suggested in his "Punjaub Sanitary Report" the flooring of such places to be of well rammed and hardened clay, upon which a layer of fresh earth or sand might be placed day by day to absorb the spilt urine. The great object in the construction of such places should be to avoid any possible contact of the excretions, either with water, or a chunamed surface. A well-rammed clay-flooring and walls, painted periodically with coal tar, would probably answer equally well in small establishments or village latrines, as "pucka" masonry lined with asphalte.

From the recent researches of M. Kuhlman communicated to the Academy of Sciences, France, it seems that the pitch derived from the distillation of coal tar, if used as a coating to *sun-dried* bricks, renders them impermeable to moisture. Now this material laid, when hot, upon a surface of well-rammed clay, would probably be found to be a most excellent substitute for asphalte, and the expense of constructing public latrines and urinals, would in consequence be much reduced. Instead of an expensive roof of galvanised iron, it might be constructed lightly of leaves, with tarred bamboo matting underneath,—the great objects of keeping out rain or dew, and very free ventilation of the building, being in either case secured. I do not pretend to a knowledge of the details of practical building, but simply desire to explain the true principles which should guide us in the erection of places of public convenience upon the "dry" system.

The use of coal tar and its products, for conservancy purposes, is comparatively of recent date, but in Indian barrack privies and urinals, it has been found most valuable in destroying the evil odours of such places. The periodical painting of the privy and urine tubs, and of the walls of privies or urinals with it, has been found to be the most effectual of all remedies hitherto proposed for destroying their offensiveness, even with the present objectionable system of carting away the excretions as a mixed and fermenting slush. I have said nothing about the use of carbolic acid, a product of coal tar, in preventing smells and nuisance. I do not think it would be required at all in a latrine well kept upon the system here proposed, though it might be usefully mixed with the collected deposits in the manure depots, at certain period of the year, when the tendency to putrefaction is most observable.

The only argument of any serious importance against the general establishment of the improved "dry" system, is that it may be found rather difficult of accomplishment in wet weather. In Madras rain falls on an average not oftener than 85 days out of the 365, but of really wet days there are certainly not more than ten or twelve in the year. At all other times evaporation from moist surfaces goes on with greater or less rapidity. I premise as a part of the scheme that sheds are to be built, for the reception and storage of dry earth, and for receiving the deposits from the latrines. These sheds might easily be constructed to hold a supply of earth to last for several weeks at a time.

The drawbacks in carrying out this mixed system would however be as nothing compared with a house drainage scheme, which for many months of the year, if worked at all, could

only be worked under great difficulties. In Bombay, where the rainfall is about double our own, and with a good water supply, a system of sewerage upon the English model is to be tried at the cost of some thirty-six lacs of Rupees.—£360,000. In Calcutta it is estimated that the drainage works in progress and in contemplation, will cost a million of pounds sterling. In both of these cities, there is a water supply already available. In Bombay the sewage is proposed to be turned into the harbour for the benefit of the shipping, and in Calcutta it is to be conveyed into a salt lake some miles inland. In neither case is there the smallest probability of the works being in the remotest sense of a reproductive nature. Indeed as regards the Calçutta scheme there are not wanting men of eminence in sanitary knowledge who have from the first prophesied its ending in a gigantic failure.*

Before spending some half a million of money in a system of sewers for Madras, it may be well perhaps for the rate-payers, who will ultimately have to defray the cost of the "improvement," to enquire whether for an expenditure of one-twentieth part of the money it may not be possible to make our chief city a model of cleanliness, and its excreta so valuable, that the cost of collection should be a mere trifle in the Municipal expenditure. A large number of latrines and public urinals are wanted, and these must cost some money. Those at present in use might I think in many instances be altered to suit the new system. The Conservancy Establishment will also have to be enlarged, but instead of being employed as now in carting away valueless rubbish such as wood ashes, straw, plantain and fig leaves, it would be engaged in a really useful work, in removing the excrement of the population to places where it could do no harm to mankind, and a great deal of good to the soil.

* See Appendix VI.

A strict Police supervision, especially in the suppression of the cesspool nuisance within private houses, would be required with the proposed system of public latrines. Private families in adopting it should be compelled to provide themselves with receptacles for fluid and solid excretions of an approved pattern to be removed daily by the conservancy establishment. I have reason to believe, that there is scarcely a respectable house in our native towns which has not a cess-pit, more or less full of human ordure, somewhere within the enclosure. With such a state of things is it to be wondered at, that the dire cholera pest should be so persistently present in the country ?

If the Municipal Associations which are already working to improve the health of towns, will only attack the root of the evil—the contamination of the soil, water, and atmosphere, by human impurities—and insist upon the complete removal of all excrementitious matters, beyond the limits of towns, we may hope by and bye to see that India's direst pest has been brought into subjection.

APPENDIX.

I.—Extract from Dr. Hathaway's Sanitary Report of the Punjaub.

Advantages of the system in the Punjaub jails.

"25. The latrines used in the Punjab jails are perfectly free from any effluvium whatever, and the essential points in which they differ from the majority of those constructed for Military use are as follows :

A. The absence of all masonry or pucca work containing lime cement.

B. The prohibition of all cess-pools or reservoirs, and all drains or pipes whether closed or open, leading in or out of the latrine or urinary.

C. The prohibition of water being used to flush the ground or flooring, which is to be kept perfectly dry.

D. The flooring being of earth, (instead of pucca masonry or stone) on which dry sand to the depth of 4 inches over a layer of well-rammed clay is strewed, and the portable vessels for the reception of both fluid and solid refuse matter being deposited on the sand.

E. The immediate removal of all refuse matter from the latrine itself, and the careful burial every evening in trenches dug for the purpose.

F. The abolition of the practice of sprinkling powdered lime in the urinaries and latrines, or in any other spot.

Essential differences in the barrack system.

26. That these several differences are very essential ones, and that much advantage, both in a sanitary and financial point of view, would be gained by the practice which obtains in the Punjaub jails, being extended to the barracks in which European troops are located, I will attempt to show seriatim.

Action of urine upon lime and concrete.

27. It is a well known fact that the acid contained in urine, (known by the name of uric acid) has a strong tendency to combine with lime in any shape, and the new compound formed thereby, is highly offensive from its strong ammoniacal odour. It is this which produces the overpowering fetor in all urinaries where lime stone, or pucca cement containing lime, is used, and there is no remedy but to break up and remove the entire brick-work with its coating of concrete, a troublesome and expensive process, especially as it has to be done constantly.

The destructive effect produced by urine on lime cement, cannot fail to be apparent to any one who takes the trouble to examine one of the urinaries attached to a European barrack, and the effluvium is apparent to a painful degree, even before entering the building. Stone slabs are only one degree less objectionable than pucca masonry, as they are mainly composed of lime-stone, joined together with lime cement.

The evil of drains.

28. For the same reason, all drains or conduits, however small, should be prohibited. They soon become saturated and tainted with the ammoniacal odour, which no washing or flushing with water can remove, they are also constantly made use of improperly, and every modification and plan of copper and zinc tubing, stone drains, and leaden piping has been tried, but all have been condemned from the urine infiltrating and finding its way beneath, where it remains giving rise to a constant and irremediable stench, which is communicated to the clothes of those who enter the building.

Superiority of the dry system.

29. The superiority of the dry over the wet system, or, in other words, the total abolition of the use of water for flushing the urinaries, requires but ocular demonstration to convince the most sceptical or prejudiced. In theory, the idea of a stream of water constantly flowing through the urinaries, appears perfect; in practice, it is known to be a perfect failure, because the urine is passed above and below, and on the sides, while the water itself merely trickles along a small portion of the conduit; added to this, the water after flowing through the urinary becomes itself polluted, and has to be got rid of. It cannot be used to lay the dust, or water the road, and hence expensive cess-pools are dug to receive it, where it remains stagnating and offensive, or it occasionally bursts through the surface of the ground, in close proximity to the sleeping barracks, and even the wells which supply the troops with drinking water. This has happened at Mean Meer more than once, as well as at Sealkote."

APPENDIX II.—*The Conservancy of Calcutta, and Towns in the North-West contrasted.*

"It is not my wish to attempt to describe in detail the condition of Calcutta. To all who are here upon the spot, the facts are notorious. The state of the Capital of British India, one of the greatest and wealthiest Cities in the world, is a scandal and a disgrace to a civilised Government. The questions that are involved are not mere questions of ordinary sanitary improvement, such as those which commonly arise in other Cities and in other Countries. The condition of this City is such that it is literally unfit for the habitation of civilised men. Even if we put aside all questions of public

health, and look on the matter as one of common decency, or as one of good Government, the state of Calcutta is disgraceful to the last degree.

It cannot be too prominently stated that the condition of Calcutta is not the normal condition of Indian Cities. I have seen the most important Towns of the North-Western Provinces, of the Punjaub, and of the Central Provinces. Their sanitary state is doubtless often in many respects most objectionable, but in comparison with Calcutta they are really almost faultless. There is no apparent reason why the difficulty of keeping Calcutta in at least a tolerable state of cleanliness should be greater than that experienced in other Indian Cities. It is true that Calcutta is larger, but on the other hand it is incomparably richer, and it possesses greater natural facilities for carrying out a proper system of conservancy than any which exist in the Cities of Northern India. Even, however, if it should be considered that the difficulties of cleaning Calcutta are greater, there is certainly no necessity that there should be such an extraordinary difference as that which actually exists.

It is often said that nothing effectual can be done for the purification of Calcutta until the great system of drainage now in progress is brought into operation. In reply to this it appears to me quite sufficient to point to the fact that the Cities of Northern India are kept in a state of at least tolerable cleanliness, and free from all, especially disgusting, nuisances, without any such system of scientific drainage. What is possible there, is beyond the slightest doubt possible here also.

So far as the theory of the conservancy of Calcutta is concerned, there seems, in the present absence of properly constructed drains, comparatively little to find fault with; but the practice is something very different from the theory. Thus, for example, the whole of the solid portions of the filth of the City is supposed to be carried away every day. But, in fact, throughout the greater part of the Native quarter of the Town, nearly all the night-soil and other filth from the houses runs, or is thrown, into the open drains on the sides of the streets, and, since these drains have generally little or no fall, the greater portion of the filth remains there. It is no exaggeration to say that the most important streets and thoroughfares of the Northern Division of Calcutta form, to all intents and purposes, a series of huge public latrines, the abominable condition of which cannot adequately be described.

This state of things appears to be mainly the result, not of the absence of properly constructed works of drainage and of public convenience, although such works are doubtless most urgently required, but of the almost total neglect of the ordinary every-day operations of conservancy."

From a Minute by J. Strachey, Esq., President of the Bengal Sanitary Commission, dated 5th March, 1864.

Appendix III.—*The Evils of the Sewage system in European Towns.*

As sewage contains nothing that is valuable for agriculture or any other human purpose beyond the excrements of men and animals, the inquiry of the Commons should properly have been into the best mode of utilising human excrements for the purposes indicated in the resolution. But this inquiry could not come before them, or occur to their minds' eye, unless another was previously instituted by them into the manner in which human excrements could be collected so as to allow of being applicable to any purpose whatsoever. Deliberation on this subject, however, became very difficult, owing to that false delicacy of Modern Society, which endeavours to remove such matters altogether from its notice, and through the very reasonable apprehension that any change in the present arrangement would involve expense and the abandonment of a comfort which all educated persons consider as a necessity of life ; for the only alternative which was seen, was between retaining the present closet and its apparatus, and returning to the cess-pool just got rid of by legal enactments. The just abhorrence in which this inexpressible chamber, with its smells, its diseases, its contamination of every kind, was held, left no doubt that all comfort-loving persons would pronounce for the retention of the hydraulic apparatus, even at the cost of an annual loss of five millions of money for guano and artificial manure, and many millions more for the purchase of the grain and meat of other countries.

To a man who argues, as a common man would express it, by contraries—to that independent inquirer who investigates the circumstances which speak against his opinion, rather than those which appear in his favour—to such a man it must appear that the inventor of the closet-pan performed an experiment expressly for his use. Supposing him to have inquired into the intentions of Nature, and supposing him to have tested the logic of the question by trying how he could defeat the objects of Nature, he would immediately have fallen upon the closet-pan. But as men generally were not thus independent and thoughtful, their estrangement from nature and her provisions could be effected by a gradual process of breaking their minds to the tolerance of loathsome places, and of foolish processes for their use. First was erected the enclosure termed the privy ; then came the wooden seat with a round hole in it ; at first it was kept detached from habitation, until when the habitation was deprived of surrounding space, and became a town house, the necessary room with a cess-pool attached, became part of the habitation. Then to guard his habitation from the contamination which he had himself necessitated, man flew to the water closet, and robbed his field of its resources, and Nature of her due.

This was so little a result of unavoidable circumstance that, on the contrary, it must have involved a total forgetfulness of the oldest habits and laws of mankind. The Jews in the desert had the spatula, with which each man dug a hole for his fæces on the top of the declivity down which he had determined that the urine should flow. Thus was Moses great as the greatest of the givers or upholders of natural sanitary laws. The Rediffs in the Turkish camp used, in the beginning of this century, to avail themselves of a similar arrangement. A hole was dug in the ground, and a tent was placed over it : slabs of stone formed a footing, and left a narrow canal between ; the hole received the solid, which was immediately covered by a shovelful of the available earth close by. The fluid excretion ran by a narrow ditch to where it sunk into the ground. The proper working of the arrangement was insured by the vigilance of a sentry deputed for the purpose. Even the instinct of animals has taught reasoning man a lesson of cleanliness by the burial of their ordure. But, neither from his ancestors nor from those he despised as inferior in what he called civilization, nor from the brute creation, did the western man, the man of the Christian era, take example. At first he dirtied everything by what he cast from himself. He next removed pollution a little further from his habitation by sending it into his rivers ; but, by a retribution of Providence, it turned back upon him in the water which he required for washing and drinking.

This state of affairs is recognised by all to be a matter of the greatest reproach to our generation ; and consequently, all would willingly remedy the evils if the means for doing so were but found. The subject now is no longer beneath the notice of statesmen, and industrious citizens even cater for the applause of vestry-men by flattering their hopes for cheaper bread and lesser taxes. Royal Commissioners have travelled through the land, and taken notice of the cry of the populations—of the bills of disease and mortality, of the experiments of the industrious, or the schemes of the speculator. The highest tribunal of the kingdom at last has recognised by the appointment of a Committee of Inquiry, that the subject is of national importance, and is fully aware that it would meet with the unanimous support of the people in town and country if it were to encourage, by legal enactments, a feasible plan for escaping the reproach of recklessly throwing away what every one knows must constitute the wealth of the nation."

J. L. W. Thudichum, M. D., F. C. S., "*On an improved mode of collecting excrementitious matter, with a view to its application to the benefit of agriculture and the relief of local taxation.*"—*Journal of Society of Arts*, 1863.

Appendix IV.—*The Conservancy of Indian Towns.*

The peculiar property which earth possesses of absorbing noxious gases, and deodorising organic remains, has long been practically known. The law enforced upon the Israelites encamped in the Desert, for the preservation of cleanliness within the camp, gives us perhaps the first history of the application of the knowledge in relation to the health of a large body of people. Whether the practice inculcated by Moses originated in an express command of the Divine Power, or whether it was of older date and merely enforced upon the people under the peculiar conditions of their encampment in the burning plains of the Arabian desert, it is not possible to determine after the lapse of thousands of years, but in either case the practical application of that law of Nature which recognises that the earth is the only true absorber and disinfectant, is shown to have been adopted at an early period in the history of mankind.

The practice of resorting "without the camp" was certainly not confined to the Jewish people. It prevailed generally throughout the East, and the outskirts of Indian towns and villages to this day bear witness to the continuance of one part of the custom, though the wise provision of the Jewish Lawgiver, by which it was rendered innocuous to the health of the people, is as universally neglected.

A consideration of the simple principle by which Earth acts as a deodoriser, and the lamentable failure of the liquid sewage system to utilise the excrementitious matters of towns, has led thoughtful men interested in the question, to devise means for saving and removing all that is valuable to the Farmer of town refuse, and doing this without injury to the health, or annoyance to the senses of the inhabitants.

The details of such a system have recently formed the subject of two important communications to the Society of Arts. One of these papers, by Dr. Thudichum, proposes means for the separation of the fluid and solid excretæ, and although his suggestions are of the highest value, we believe that a long time must necessarily elapse before they can be turned to practical account. If no other difficulties existed, there remains the fact that the Londoners have just been taxing themselves to pay for the enormous sewage works intended to relieve the Thames of its foulness, and are therefore not in a temper to listen to proposals involving additional outlay, and besides rendering abortive all their past expenditure. The scheme of Dr. Thudichum, if it is ever tried at all, will have to be introduced in some new locality, where the Municipal authorities have not tied and bound themselves down to any established system.

The other paper, founded upon principles which are more applicable to small or scattered communities, than to thickly populated towns, is likely, we think, to have an important bearing upon the subject of conservancy in India. The Revd. H. Moule, in his observations on a "*system of earth sewage*" has

sketched the outline of a plan which appears to us better adapted to meet the peculiar habits of the people and their requirements in a sanitary point of view, than any mode hitherto proposed. Mr. Moule's principal object has been to suggest means for the utilisation of human waste. In all the methods of dry conservancy in India, this view of the subject has scarcely met with any attention. The removal of refuse from barracks to pits situated at some distance, and the rapid burial of all obnoxious matters, has been the chief end kept in sight. Mr. Moule proposes not only the removal of sewage in a dry and perfectly innocuous form, but also its employment as a fertiliser of the soil, undiminished in value by the process of removal. He, in a great measure, solves the problem which has been the bone of contention with Engineers, Sanitary Officers, and Agriculturists, during the past twenty years, and shows how feasible is the idea of complete transformation of excretæ into superabundance of vegetable life. He says: "such a proof indeed I am prepared to give; "but so great is the sway of prejudice, of self-interest, and, shall I say, of "ignorance, against it, that though I should establish my scheme beyond all "contradiction, my proof would not, for any practical purposes with reference "to our great cities, have at the present time the weight of a feather. It will "probably require another half century of experience to convince the public "that the present drainage system, while relieving particular premises and "special localities, is at the best but a shifting of an evil, increasing in its noxi-"ous character as it goes along from one spot to another, and that even the "boasted and extravagant drainage of this metropolis (London) is only a pallia-"tion and a temporary relief. The day will come when, from the increase and "spread of population higher up the river, an equal amount of pollution to "that which is now to be withdrawn from it, will be poured into the Thames, "and when, from the increase of filth, sand, and rubbish poured into them, the "main sewers calculated for the present evil will then be ineffectual for their "purpose."

"In the establishment of the earth sewage system, no public works are "required, while the three and a half millions being spent by the Metropolitan "Board for the greater efficiency of the public works now existing, would "have defrayed double the cost of all private works of the earth sewage system in "London; and the manure saved would at the very lowest estimate have "produced a clear profit of £50,000 a year."

The system which Mr. Moule has termed earth sewage, is based on the fact that a very small quantity of earth, garden soil, or powdered clay, *so long as it be thoroughly dry*, is sufficient to render innocuous a large amount of animal excretions. "Three half pints of earth dried in the atmosphere and "passed through a sieve with a mesh of one-eighth or one-quarter of an inch, "is amply sufficient for each use of an earth closet. It at once stops emission "of offensive smell; it prevents fermentation; and these results are so complete and lasting, that either the same day, or after a week, or even a longer "period, the mass of soil and earth can be removed from the room and the "premises without any offence." The earth may be again dried, sifted, and used over and over again, without loss of its deodorising power.

If the statement we have above quoted is to be depended upon, and the means of determining the truth of it experimentally, are within the reach of every householder, we are inclined to think that in India we need not trouble ourselves about sinking lacs of Rupees in the construction of drains, but that it would be the wisest possible course to see how far the existing difficulties as regards the practice of dry conservancy can be surmounted; and having already settled that this system is the one best adapted to the peculiarities of a tropical climate, no effort should be spared to make it as perfect as possible.

The system of earth sewage, Mr. MOULE tells us, has been already tried with great success in cottages and public institutions. At the work-house school of Bradford-upon-Avon, containing 55 children, the latrine has been reduced from a condition of "noxious pungency" to a state of inoffensiveness, by the simple method of keeping a box of dry earth with a scoop in the place, and requiring the children to throw in a scoopful on each occasion of its use.

The whole quantity of earth used in a period of five months was only a ton and a half, but this had become a mass of valuable manure.

The mechanical genius of the British nation has been appealed to, with the view of devising means for applying the earth without manual labour, and already "patent earth closets" self-acting in their nature, have been invented, one of which, in Mr. MOULE's estimation, as regards simplicity and efficiency of action, is "perfect." As to the mode of obtaining earth in the case of a detached house, let Mr. MOULE speak for himself. "All that I have to do is, to take "a few barrow loads of earth from my garden, and allow it to lie for a time to "dry. When used sufficiently in the closets, instead of being a loss to the "garden, it is returned as money borrowed with interest. It has become "manure, highly concentrated and so easy of application, that a handful or two "may be equal to a barrow load of ordinary manure. This I have proved by "many experiments."

"If from this we rise to a large establishment, say a barrack with two "troops of Cavalry, the same farmer who supplies straw for the horses, as soon "as he sees the value of the human excrement, and can have the opportunity "of removing it, will supply earth for the closets. He *will* not grudge the

"earth from his fields, which is to be returned to him after a time equal in "value, as it may be made, to superphosphate, or crushed bones, or guano."

We have quoted from Mr. MOULE's paper sufficiently to illustrate the general principle, and the arguments in favor of earth sewage. Those we may briefly recapitulate as—

1. Costly public works not required.
2. No waste of matters which have been taken from the soil.
3. Cleanliness and absence of offensive smells.
4. Prevention of those diseases which depend upon poisonous gases evolved in the fermentation of human deposits.

These recommendations in a country which is already practically acquainted with the evils of wet, and the advantages of dry conservancy, should be sufficient to ensure a fair trial of the new system in all private detached houses, public institutions, barracks, and hospitals.—*Madras Athenæum and Statesman, July 28th*, 1863.

APPENDIX V.—"*Earth Sewage.*"

In a paper on the "Utilization of Town Sewage," which is contained in Vol. XXIV., Part I, of the *Journal of the Royal Agricultural Society*, Mr. Lawes has written thus:—"No one will doubt that if the sanitary requirements of the nation could be attained by any system which would preserve the excrements of the population free from admixture with water, and present them for use at once undiminished in value by decomposition, and in a portable and innoxious condition, the land of the country devoted to the growth of human food might, by their application to it, be greatly increased in its productiveness. The question of the sanitary arrangements of our towns was taken up by our Engineers before Agricultural Chemistry was much studied; and they have committed us to plans which, though they effectually remove the noxious matters from our dwellings, must greatly limit the area and mode of their agricultural utilization, and which, at the same time, have tended to the pollution of our streams. To say nothing of the enormous cost that would be involved in entirely subverting the present methods of removing the excrements of the inhabitants of our large cities from their dwellings, it must be admitted that no feasible scheme has yet been proposed by which this could be accomplished without the use of water. Such is certainly a great desideratum, but, perhaps, a consummation more to be wished than expected."

By thus placing this extract from Mr. Lawes' paper at the head of that which I am about to read, I would not lead to the expectation of any attempt on my part to prove that, for the removal of the excrements of the inhabitants of our large towns from their dwellings, the scheme I propose is perfectly feasible. Such a proof, indeed, I am quite prepared to give; but so great is the array of prejudice, of self-interest, and, shall I say, of ignorance, against it, that, though I should establish my scheme beyond all contradiction, my proof would not, for any practical purpose with reference to our great cities, have, at the present time, the weight of a feather. It will probably require another half-century of experience to convince the public that the present drainage system, while relieving particular premises and special localities, is at the best but a shifting of an evil, increasing in its noxious character as it goes along from one spot to another, and that even the boasted and extravagant drainage of this Metropolis is only a palliation and a temporary relief. The day will come, when, from the increase of the population higher up the river, an equal amount of pollution to that which is now to be withdrawn from it, will be poured into the Thames; and when, from the increase of filth, sand and rubbish poured into them, the main sewers, calculated for the present evil, will then be ineffectual for their purpose. There is only one observation which I would make on my scheme with reference to its application to large cities in which the water drainage now exists. Mr. Lawes says that the subversion of the present system in favor of any other, would be attended with enormous expense. Now, in the establishment of the earth sewage system, no public works are required, whilst the three and a half millions being spent by the Metropolitan Board for the greater efficiency of the public works now existing, would have defrayed double the cost of all private works of the earth sewage system for London; and the manure saved instead of wasted would, on the very lowest estimate, have produced a clear income of £50,000 a year. But enough of this; I will proceed to state—

I. The principles of what I have ventured to call the system of earth sewage.

II. The mode of their application in closets, or commodes and urinals.

III. The provision of earth for single dwelling houses, or for large establishments, and for our smaller towns.

I. The peculiar adaptation of various kinds of earth for the complete and economical removal of excrementitious matter consists not in the mere fact that such earths are good deodorizers. This has long been observed and known. But it was not known, until a very recent period, that, under certain circumstances, the quantity of earth required for this purpose is very small. When the contents of a vault or cess-pool have been allowed to ferment and generate offensive gases for months and years, it has been found that the proportion of earth required to destroy its offensiveness is immense. If, however, the

evil be taken in detail, and the remedy applied at once, the reduction in the quantity required is incredible until tried. Three half-pints of earth dried in the atmosphere and passed through a sieve with a mesh of one-eighth or one-quarter of an inch, is amply sufficient for each use of an earth closet. It at once stops emission of offensive smell; it prevents fermentation; and these results are so complete and lasting, that either the same day, or after a week, or even a longer period, the mass of soil and earth can be removed from the room and the premises without any offence. If when thus removed a coarse sieve be used, the earth which passes through the sieve will in a day or two be dry enough to be used again, while all that which will not pass through, being thoroughly mixed together by a spade, or in any other way, forms a highly concentrated and inoffensive manure. Or, if on removal the whole mass be thus mixed together and left to dry, it may with equal absorbing and deodorizing efficacy be employed in the closet again. And so remarkable is this capability of earth for the absorption of such substances and gases, that I have myself subjected it to this repeated action ten times.

Here, then, in the case of a single closet is exactly that which Mr. Lawes requires. Indeed, if comfort and sanitary considerations be taken into the account, there is more than he requires; for, together with the entire suppression of fermentation and of the escapes of noxious and offensive gases, there is here "the preservation of the excreta free from admixture with water; and they are presented at once undiminished in value by decomposition, and in a portable and innoxious condition."

II. As to the mode of application of earth in closets and commodes, it is obvious that it can in many cases be done without the use of machinery; and thus, in fact, it has been applied in not a few cottages, and amongst other public institutions, in the work-house school of 55 children, at Bradford-on-Avon. A box of dry earth, with a scoop, is placed in the privy, and the children are required to throw in a scoopful on each occasion of its use. This has been attended with such complete success, that the Vice-Chairman of the Board of Guardians of the Bradford Union states that, where all before was "noxious pungency," there is now no offensive smell. And as to the quantity of earth used, he states that, from the repeated use of the same earth, the whole mass at the end of five months amounted to no more than 1½ tons, but that a mass of valuable manure.

It soon became clear, however, that in such cases self-action would be advisable, and in some cases almost a matter of necessity, whilst an application of the earth by machinery would be far more convenient, and might be more immediate than by hand. Accordingly, a very simple contrivance was tried for a time, which, however, soon in its use betrayed two or three defects. In consequence of these defects, Mr. James White, of Dorchester, applied his mind with much ingenuity and patience to a subject attended with far more and greater difficulties than any one who has not gone into it can conceive, and has produced in the patent earth closet of his manufacture that which, while almost equally simple with the former plan, obviates all its defects, and is, in my estimation, perfect. In its simplest form it may be thus described. At the back of the commode or closet is a box or reservoir filled with dry earth, at the lower part of which is a revolving hopper with four compartments, each of which is capable of containing the required quantity of earth. By a very simple piece of machinery, the weight of the body in sitting down turns this hopper and fills the compartment with earth. On the person rising from the seat, the hopper revolves one-quarter of its circumference, and throws the earth by means of a shoot directly on to the soil and under the pan. The same operation can, of course, be performed by the use of a lifting handle, and in this case the application can be instantaneous, an advantage which, in sick rooms and in hospital wards, appears to me to be incalculable. The excreta and earth together can of course be received, in the case of a commode, in a bucket, or from a fixed closet passed through a pipe or shaft into a receptacle below, from whence its removal would be the most practicable. There is another form of closet, consisting of a set of knives in the form of a screw, which mixes the mass and at the same time cuts the paper to pieces, and forces the whole out in a perfectly inoffensive form. But the description of this I leave to the manufacturer. As to the use of earth in urinals, no machinery is necessary, and its efficacy is complete. A truck or pit, eighteen inches or two feet deep, and filled with dry earth, occupies the space both under the standing place, and three or four feet in front of this. The standing is formed of an iron grating, the continuation of the iron railing which forms the barrier. All offensiveness is thus prevented, and a valuable manure produced. Public urinals on this plan in the metropolis, and in large towns, and at our railway stations, instead of the nuisances such urinals now are, might be completely inoffensive and innoxious, and might be made to pay. One ton of earth or of London clay would be sufficient for 1,000 uses, and dried at a temperature under boiling heat, might be used for the same purpose and with increase of value again and again.

III. In speaking of the supply of earth for closets, &c., I will take first the case of a detached house with a garden. All that I, in such a case, have to do is to take a few barrow loads of earth from my garden and allow it to lie for a time to dry. When used sufficiently in the closets, instead of being a loss to the garden, it is returned, as money borrowed, with interest. It has

become a manure, highly concentrated, and so easy of application that a handful or two may be equal to a barrow-load of ordinary manure. This I have proved by many experiments. If from this we rise to a large establishment, say a barrack with two troops of Cavalry, the same farmer who supplies straw for the horses, as soon as he sees the value of the human excrement, and can have the opportunity of removing it, will supply earth for closets. He will not grudge the earth from his fields, which is to be returned to him after a time equal in value, as it may be made, to superphosphate, or crushed bones, or guano. But if his soil be light and thin, and he have clay in the neighbourhood, then he can easily and cheaply procure that substance, and if he mix it with such ashes as he can get, or with street-sweepings, he obtains by the admixture a most valuable manure, exactly suited to his land. Or if, in the last place, we take the case of a town, which either is in such a position that it cannot be drained, or, the inhabitants of which, being unwilling to enter on the expensive, and now doubtful, system of water drainage, should be disposed to adopt the earth system, a company could provide, according to the circumstances of the neighbourhood, clay, peat, earth, silicate of alumina, or any other earth or sub-soil, except chalk or lime stone, and adding to it, if they please, soot or any other fertilizing materials, they might send it with as much ease as they send artificial manure to those parts of the country, which manure prepared from any of those earths and substances would best suit. For instance, the manure of London, instead of being either wasted in the sea, or, not much better, wasted on a few thousand acres in the marshes of Essex, if mixed with the clay which is everywhere at hand, and with the soot and some ashes and street-sweepings, might convert the sandy heaths to the west and south-west into fruitful pastures and corn-fields. There would, in the one case, moreover, be no transfer, as there is in the other, of the locality of malaria and offensive smell from the town to the country. And, whilst the whole neighbourhood of the Essex marshes will abominate the daily influx into those marshes of a lake of filthy slush, the most offensive part of that slush, freed from the water, and converted by the earth into an inodorous and valuable fertiliser, would, by the owners and occupiers of the heaths of Surrey, Hants and Dorset, be not only welcomed but readily purchased.—*On a system of earth sewage, by the Rev. H. Moule. Paper read before the Society of Arts, 5th May*, 1862.

Appendix VI.—*The Drainage of Calcutta.*

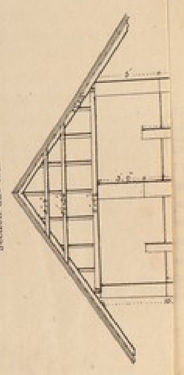
"Calcutta is a City built in a rice-field, which is another word for swamp, or place in which all malarious venoms,—ague, dysentry, asthma, cholera,—breed eternally, until thorough drainage breaks up their nests. This may be said of nine-tenths of the other towns in Bengal Proper, but we have close beside us a cause of destruction which they have not—a vast salt lagoon hemming us in landward and poisoning every breath of cool air which comes to our greedy lips from the always unwholesome East. By what appears to me the greatest and most calamitous sanitary blunder on record, it occurred to the minds of the Drainage Commissioners of 1857, to utilise this "Dismal Swamp," this "Slough of Despond," reeking with marsh damps and with the decomposed elements of myriads of dead creatures which, in deference to an esteemed friend and brother-sanitarian, I must say do not stink, but send up continually to use an opposite quotation of his own "an ancient and very fish-like smell." It occurred, I say, to these Commissioners, that the waters of this salt swamp robbed the breeze of its malaria, as those of rivers and sea estuaries do, and that, because salt preserves meat, these brackish waters would have the power to disinfect the whole sewage filth of this City, which is, accordingly, to be voided into them !

The gentlemen who made this frightful mistake are good men and true, whom I heartily honor ; but, to say nothing of a host of authorities in modern times, there has been no English physician, since the days of Queen Elizabeth, who would not have told them that the most pestilentially deadly of all swamps are those which contain salt water. * * * * * *

The drainage system ought, on no account, to include the removal of fœcal excreta by the sewers. The whole of the bath-room and tatty excreta should be removed by a system of conservancy. The present tatty arrangements should be thoroughly re-organized. Those public necessaries which now occupy objectionable sites, should be removed, and latrines nearly like those first introduced at Agra, should be established in comparatively safe and open situations. The whole ordure of the city should be removed, nightly, in well-constructed trapped iron conservancy carts, drawn by horses. * * * * * * * * *

The feculent excreta and every kind of solid filth, road scrapings, and sweepings, stable-litter, the refuse of knackeries, markets, tan-yards, urinaries, gardens, cook-rooms, &c., &c., &c., being collected and carried away in conservancy carts, the fluid sewage of the city, that is all liquid matter from manufactories, markets, gas-works, cook-rooms, &c., &c., which could not be removed in conservancy carts, being properly diluted and flushed onward with an abundant supply of fresh water, at high pressure, should be voided by a system of under-ground sewers of very moderate capacity, the inlets of which ought to be secured against the entrance of storm-water and of all solid refuse, while the whole rain water, except such portion of it as may be required to flush the sewers, &c., should be carried off by a system of open surface drains."
—*Dr. Norman Chevers*, Indian Annals of Medical Science, No. xvii, Page 63.

Section thro' A.B.

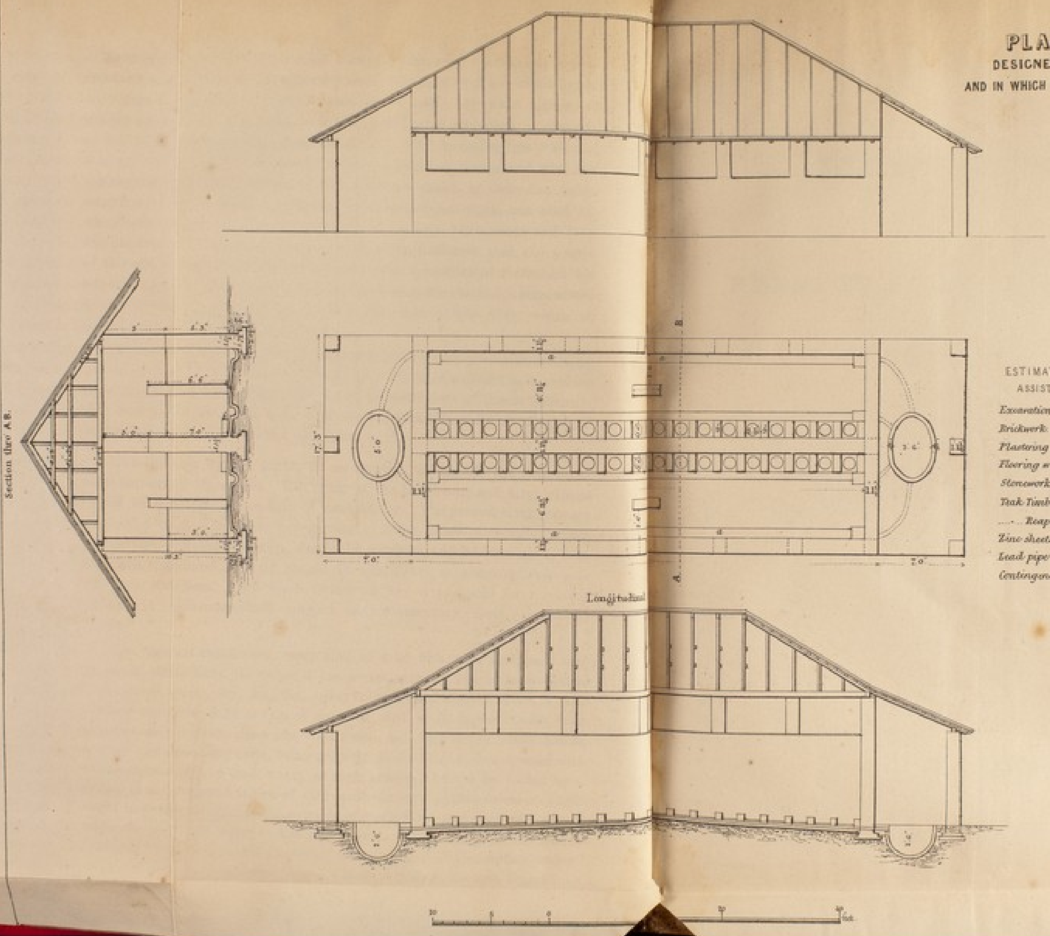


PLAN OF A LATRINE

DESIGNED FOR THE USE OF NATIVES, AND IN WHICH THE EXCRETIONS CAN BE SEPARATELY COLLECTED.

REFERENCE.

— a. Urinal. —



ESTIMATE OF LATRINE AS GIVEN BY B. ANDERSON ESQ[re]
ASSIST[T] CHIEF ENGINEER, MADRAS RAILWAY.

Excavation	Cub. yards	54	7/4/-	13	8	-
Brickwork	"	65	6/-/-	390	-	-
Plastering	Square	20	6/-/-	120	-	-
Flooring with asphalte	"	14	23/-/-	322	-	-
Stonework	Cub. feet	36	1/-/-	36	-	-
Teak Timber	"	130	3/8/-	455	-	-
" Reapers	per hundred lin. f[t]	1800	5/-/-	90	-	-
Zinc sheeting	Tons	1⅓	524/-/-	698	10	8
Lead pipe	Lin. feet	28	1/8/-	42	-	-
Contingencies				216	13	4
			Rupees	2384	-	-

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—*Dr. Norm*

THE NEW PROCESS

FOR THE

PRESERVATION OF MEAT

FOR FOOD,

By J. MORGAN, F.R.C.S.I.,

PROFESSOR OF ANATOMY, ROYAL COLLEGE OF SURGEONS, IRELAND.

DUBLIN:
FANNIN AND CO., GRAFTON-STREET,
BOOKSELLERS TO THE ROYAL COLLEGE OF SURGEONS.

1864.

The following pages will, I trust, serve to direct attention to a subject hitherto strangely neglected, yet of the greatest importance both with regard to the health and efficiency of the seaman and soldier, and to the financial question of the preservation of meat for food, as shewn by the subjoined comparative outline:—

BY THE METHOD NOW IN USE.	BY THE NEW PROCESS.
In the rubbing and laying in salt the meat is deprived of its nutritive qualities to the extent of one-third (according to the calculation of so eminent an authority as Baron Liebeg*); so that, apart from the injury done by the absence of these qualities, the financial loss is enormous—in a single curing season amounting to £25,000, or one-third the cost of 5,000 oxen, producing 5 cwt. of meat each, at £3 per cwt.	There is no rubbing or laying in salt, and therefore no abstraction of nutritive materials or financial loss.
	An entire ox can be preserved in ten minutes, and at a cost of about 6d. or 8d.
The meat is then packed in salt and brine, and a further abstraction of the nutritive and essential elements thus takes place, proportioned to the length of time in cask.	The flesh is put to dry as soon as convenient, and when dried, is packed in barrels or cases with sawdust or some dry material, and is therefore more portable than by any other method.
When thus injured and rendered difficult of digestion by being hardened, the meat can only be prepared for the table by boiling, any remaining soluble elements being thus as far as possible taken away and rejected.	The meat can be eaten either uncooked, or as beefsteaks, roasts, hashes, soup, &c., thus admitting of a suitable nutriment for invalids, and also of variety.
In consequence, a further expense is incurred in endeavouring to supply the natural elements taken-away, by using lemon juice, &c.	The elements of vegetables as antiscorbutics can be artificially added to the flesh, thus presenting meat and vegetable at the same time.
From the necessity of curing in the winter season, the price of the meat is considerably raised, and a large quantity of stores must be prepared at the same time.	Wherever a ship touches and at all seasons meat can be prepared for stores on the spot with great economy.
	The apparatus necessary for preserving any number of animals is portable by one man, and costs but a few shillings. No special machinery or building is necessary.

* *Letters on Chemistry*, p. 448.

THE NEW PROCESS

FOR THE

PRESERVATION OF MEAT FOR FOOD.

The subject of the Preservation of Food, particularly of flesh food, has lately attracted so much attention in a hygienic point of view, and such various means have been practised to arrive at a suitable mode of effecting this object, that it becomes a question of great interest and importance,—and just now attracts a well-merited share of attention.

To a nation with such a navy, merchant marine, and military force, the great significance of the subject cannot be over-estimated—not only in its *scientific*, but in its *financial* point of view; for where the supply of flesh food for so many thousands of men is concerned, the first consideration which should, *as a duty*, be entertained is, how far the means adopted are capable of securing preserved meat *in a perfect condition*, with regard to *composition*,—and, secondly, how far the material produced is at all *commensurate in perfection with the cost*. I would propose, briefly, to enquire if these conditions are fulfilled by the present means, and if the usual processes cannot be improved or superseded by that introduced by me to the notice of government, as a *scientifically correct* and *mechanically convenient* method, possessing all the requisites for securing perfect results, and adapted to meet any emergencies that may arise, as during the late Crimean war, when the defects not only of the supply but of the quality of the meat for food, were so evident and gave origin to such wide spread mischief, as shown by the statistics that, from October, 1854, to April, 1855, with a healthy climate and a stationary army, the rate of disease rose to the alarming amount of 39 per cent. for the infantry, and 45 per cent. for the troops in the front—and the proportion of those lost by sickness to those by wounds was, if we take the whole war, as 16·211 to 1·761. That this high rate of ill health was owing chiefly to the imperfect food is admitted by all. It has been aptly remarked,* "If we were asked to prescribe a dietary best adapted to give rise to gastric irritation and dyscrasial disease, could we suggest one more potent than salt pork, hard biscuit, and raw rum?" But if, in addition, we find that this meat could have little or no nutriment, that its most important constituents are taken from it in the process of "cure" and packing, that it is rendered more difficult of digestion, and it no longer contains any of the natural elements suited for the maintenance of health, we may fully understand the speedy appearance of the "great destructive agent scurvy," and the truth of Dr. Macleod's remark † that "this scurvy was our worst enemy and wrested from us more wounded men than even the conical ball."

It is plain that the meats preserved for stores should not only be capable of preparation in as economic a form as possible, and of easy portability and transport, but that they should be in a suitable condition for replacing the wants and supplying the nutritive elements necessary to perfect health. For the sailor this is imperative, who, while exposed to the vicissitudes of weather and temperature, and undergoing frequent and often prolonged exertion, must, at the same time, be supported on a more or less artificial diet, with but little vegetable supply, or even (by the present method), of the *natural* supply contained in flesh originally obtained from the vegetable kingdom; for it has been too much the habit to consider the mere fact of "*cure*" as the sole object to be gained—forgetting that meat may be so preserved with but *little, if any*, nutritive power, and, still worse, be served out as food, representing nutrition. For, to use the words of the most unquestioned authority—Baron Liebeg—who has so fully

* *Macleod's Surgery of the Crimean War*, p. 26. † *Ib.* p. 71.

treated of the subject: "It is obvious that if flesh employed as food is again to become flesh in the body, if it is to retain the power of reproducing itself in its original condition, none of the constituents of raw flesh ought to be withdrawn from it during the preparation of food. If its composition be altered in any way, if one of the constituents be removed, a corresponding variation must take place in the power of that piece of flesh, to resume in the living body the original form and quality on which its properties in the living organism depends." *

Therefore, it is a matter of primary importance that the meat should retain the *natural elements sufficient for perfect health*, even without the addition of vegetables, as sufficiently proved by the well-known illustration of carnivorous animals, who derive the requisite vegetable elements from the flesh of the herbivorous animals on which they prey; while, amongst mankind, the fact that the inhabitants of the Pampas, the North American hunting tribes, and the Esquimaux, who are only flesh-eaters, enjoy perfect health, shows the sufficiency of flesh in its *perfection* for sustaining existence, where, either from inability to obtain, or from habit, vegetable food is not used. It is not convenient here to refer to the question of the necessity or advantages of flesh diet, or to notice the superiority in bodily endurance and mental activity of the flesh, over the vegetable eating nations, to shew that the thinking mind and working body are equally influenced by the perfection and quality of food. "The commonest observations," says Liebeg, "teach us that flesh possesses a greater nutritive power than all other kinds of food." "It is certain that three men—*one* of whom has had a full meal of beef and bread,—the *second*, of cheese or salt fish—and the *third*, of potatoes, regard a difficulty which presents itself from entirely different points of view, the effect of the different articles of food on the brain and nervous system is different, according to certain constituents peculiar to each of these forms of food." † So that, taking a scientific view of the necessity of a proper supply of flesh materials, it becomes not merely a matter of individual interest, but,

* *Leibeg's Letters on Chemistry*, p. 467.
† *Chemistry of Food*, p. 122.

for the army and navy, a *serious duty* to enquire how far the soldier or sailor is furnished with a substance capable of fulfilling its proper office of *supplying the wants of the system.* The necessity of such has been too often proved in warfare—the meat, even if enough in quantity, or rather *bulk*, being deficient in quality and nutritive power. Consequently, the failure of the physical and moral powers follows, and, as illustrated by the above quoted remark of Liebeg, there is neither the mental activity to project, nor the ability and energy to accomplish, important measures under circumstances where these qualities are particularly required. Dr. Macleod, in his "*Notes on the Surgery of the War in the Crimea*," observes:—"The constant repetition of the same rations, the absolute uniformity in every item of food, is but too apt to occasion aversion, especially with those in whom disease is beginning to show itself. I can speak from personal experience as to the strong predisposition of this one cause in giving rise to the fever designated 'Crimean,' and I know of few things which had a more undoubted effect on the health of the troops."

In the first place it is necessary, in order to understand rightly the objects to be attained, that the composition of flesh and its various constituents, with their uses in the animal economy, should be referred to. It may be stated in general terms, that flesh contains per cent. of *water* 76 *to* 79; of *albumen*, 2 *to* 14; of *fibrine*, 17 *to* 18; that, on an average, in ten pounds of flesh the soluble matter, after coagulation of the albumen and coloring material, does *not amount to three ounces*. The very smallness of these matters shews the great necessity of retaining them, except the water, intact in the flesh, which consists of—

1. Water.
2. Albumen.
3. Fibrine.
4. Phosphoric Acid.
5. Lactic Acid.
6. Potash Phosphate.
7. Potassium Chloride.
8. Kreatin.
9. Kreatinin.
10. Inosinic Acid, &c.

Ashes of Flesh (after Keller).

Phosphoric Acid	36·60
Potash	40·20
Earths and Oxide of Iron	5·69
Sulphuric Acid	2·95
Chloride of Potassium	14·81
	100·25

It will be now convenient and useful to allude to each of these constituents separately, with reference to their office in the animal economy.

1. *Water*, which is so constant a constituent of the body, varies in different kinds of flesh, and with the age of the animal—but always forms a large proportion, three-fourths, or more. It is evident that this element can be harmlessly dispensed with, as it can be always added artificially in the preparing of food—but is useless, as well as inconvenient for transport—occupying unnecessary space and increasing weight, while it is ever ready to facilitate decomposition.

2. *Albumen*, as contained in a state of solution in the juice of muscle, surrounds and bathes all the muscular fibres, and is found in varying proportion. It supplies, as food, the basis from which the structures of the body are formed. "Everywhere throughout organized nature where animal life is developed, we find the phenomena of life depending on albumen." * The familiar example of the composition of the egg shews how, with merely the assistance of external air admitted through the shell, all the complex structures of the body of the chick are fully formed, and its organs perfected for supporting an independent existence on emerging from the shell. Albumen is the "starting point" of the whole series of tissues. *The necessity for retaining* this material in flesh is therefore obvious. It is on the abundance of this albuminous fluid, and its retention in the meat, that the tenderness depends; hence the rule in good cookery, of either plunging meat at once into boiling water, or putting it close to the fire at first, to make a crust of coagulated albumen, and so retain its juices. The coagulation of the albuminous substance around the fibres prevents their hardening and contraction.

As the albuminous matter is deficient in the flesh of old animals, it accounts for the toughness of the meat. If flesh be mechanically prepared, by depriving it of the albumen, the fibre becomes hard and horny, and therefore difficult of digestion.

* *Liebeg's Letters on Chemistry*, p. 371.

By the method of "cure" at present in use, the greater part of this highly nutritious albumen is abstracted, and merely used for "fining" or cleaning the pickle that is withdrawn from the pickling tanks. It is calculated that in Glasgow alone, albumen equal to 187 tons of meat is lost per winter, which, at 6d. per pound, equals a loss of £10,472 worth of nutritious material. What the loss on a large scale is, may be conceived.

3. *Fibrine*, which forms 17 to 18 per cent. of flesh, and about 70 per cent. of the flesh when *dried*, is, in a chemical view, analogous to albumen, and in the same relation to the albumen of the blood as solid and fluid albumen would be. In the process of digestion it is softened and dissolved, as is the boiled, *i.e.*, coagulated white of egg. If the fibrine when long boiled be examined after the formation of soup, it is found hard and difficult of digestion.

By the method of "cure" at present used, the fibrine is the principal residue, becoming of course hard, and in a little time so hard as to require a saw or chopper instead of a knife—no doubt the material in this state is not liable to decompose, and on this account hardness is looked on as one of the tests of good "cure"—unfortunately at the same time being a *test of deterioration in quality and inaptitude for food.*

These materials of meat, though popularly believed to be the essentials, are *of themselves incapable of supporting the vital process;* some other compounds, as tabulated above, are requisite. The well-known efficacy of soup in restoring strength to the body and perfection to the digestive process, (though this soup does not contain the fibrine of the meat,) and the inutility and vapidness of the meat after its preparation, are every-day striking though unobserved proofs. Analysis, however, bears out experience on this point.

	*When boiled there enter the soup	and remain in the exhausted meat
Phosphoric Acid	26·24	10·36
Potash	35·42	4·78
Earths and Iron	3·15	2·54
Sulphuric Acid	2·95	
Chloride of Potassium	14·81	
	82·57	17·68

* *Liebeg's Letters on Chemistry*, p. 446.

Two converse experiments performed by the Gelatine Commission in France, (see *Rapport à l'academié des Sciences*, August 2nd, 1841,) and giving its results after continuing experiments for *ten years*, show the importance of these other constituents of flesh. A dog was fed daily with half a pound of boiled flesh softened in water, *thoroughly expressed*, and freed from fat as much as possible, but lost, in the course of forty-three days, a fourth of its weight; after fifty-five days his emaciation was extreme; he could hardly eat the quarter of his ration, and his utter exhaustion was evident to the eye. On the other hand, dogs fed with the same amount of raw flesh, which, of course, contained more water and less meat, continued healthy. The converse results were obtained thus:—

A young dog (female) was for some time fed on bread and gelatine. She had lost one-third of her weight, was excessively weak, and about to die. *Four table-spoonfuls of soup* were now added to each mess, and from that time the animal regained strength.

These experiments, amongst many, show the great necessity of those other compounds, though contained but in small quantity. We may, therefore, further inquire into their composition and objects, premising that "Flesh contains in its composition certain universal conditions of digestion and nutrition, in regard to which other kinds of animal and vegetable food resemble it. In its fibrine and albumen it has a definite value for the production of the fibrine and albumen of blood; in its fat, a value for the production of heat; and in its salts, a value for the production of both heat and blood, as well as for the secretory processes. In addition to these, flesh possesses, in the very remarkable constituents of the juice, *a peculiar value* for certain processes of a higher order, by which it is distinguished from all other forms of food."*

* *Liebeg's Letters on Chemistry*, p. 448.

4. *Phosphoric Acid* is contained largely in the juice of flesh, and found in different chemical forms, amongst others of "meta phosphoric," (which I propose, as will be seen by-and-by, to add by my process, being in this form recommended by Professor Galloway of Dublin.) From the constancy of its occurrence, not only in flesh, but in other substances of food, especially from the vegetable kingdom, its office has been particularly enquired into. We find it forming in usual articles of food, as

In ashes of Ox flesh . . .	36·60	per cent.
" Salt Cod fish . .	16·775	"
" In Yolk of Egg . .	36·74	"
" Cheese, Gruyere .	45·00	"
" Tea (Souchong) .	9·88	"
In Wheat . .	from 40 to 60·00	"

In the Ashes of Wheat.

Alkaline Phosphates . . .	49·18	per cent.
Earthy Phosphates . . .	23·13	"
Free Phosphoric Acid . . .	27·69	"
	100·00	

Though its exact properties cannot be defined in all cases, yet, from the constancy of its occurrence, we may see it is "indispensable to the vital process."* As it is found largely in flesh-juice, it is necessary to the normal state of the muscles of animal and organic life. It is a constituent of the viscera, liver, lungs, kidneys, &c., and of nervous matter; but in the latter is deficient in childhood, old age, and idiotcy, therefore essential to the composition and perfection of the brain. It is also contained in the gastric juice, explaining the advantage of soup to stomachs of low digestive powers, thus not only supplying the wants of the body, but the gastric fluid itself. Other, and if possible more important offices, are to be fulfilled with regard to the blood by this acid. If we reflect for a moment that the blood, which is so freely distributed to every minute and remote part of the body, is contained in capillaries of extraordinary and even microscopic minuteness, we may

* *Liebeg's Letters on Chemistry*, 490.

conceive of what tenuity must be their walls, and how much more permeable than blotting paper, and yet these minute vessels, though immersed in a fluid muscle-juice, do not allow the filtration of one of these fluids into the other; nevertheless, the explanation as proposed by Liebeg is simple; for, as the contained fluid, blood, is alkaline, and the muscle-juice surrounding, acid, the necessary conditions of an electric nature exist for preventing the interchange of these fluids. In correspondence with this idea, Professor Buff constructed a pile, consisting of discs of pasteboard moistened with blood, of flesh, and of brain. This arrangement caused a very powerful deviation of the needle of the galvanometer, indicating a current in the direction from the blood to the muscle. When water was substituted for brain, the action was weaker; the current arising from contact of blood alone with the platinum was in this case the reverse.*

The alkalinity of blood is owing to the phosphate of soda which is "indispensable to its normal constitution." As it has the peculiar and wonderful property of conveying carbonic acid in large quantity, and when, having given it off in respiration, still retaining its original properties, "the serum of blood absorbs 166 times more carbonic acid than could be absorbed by the very largest proportion of carbonate of soda which it can be supposed to contain;" and "there is no known salt the chemical properties of which approach more closely to those of the serum of the blood than the phosphate of soda. There is none more fitted for the absorption and entire removal from the organism of carbonic acid."† The necessity of this compound of soda in the blood is proved by the eagerness with which animals living on *inland* plants, which *contain potash largely*, but not *soda*, impelled by a natural instinct, seek the "salt licks" and other means of obtaining salt (chloride of sodium). By the action of chloride of sodium on phosphate of potash we have the phosphate of soda supply found so necessary to the blood, and chloride of potassium for the muscle-juice. We find, therefore, phosphoric acid in some form everywhere necessary, spe-

* *Liebeg's Chemistry of Food*, p. 104. † *Ib.* 117.

cially to blood, gastric juice, and muscle, and serving in the great processes on which life depends—of circulation, animal heat, digestion, &c. As it is supplied in flesh in comparatively small quantity, great care should be taken to retain it, or even to make an artificial addition in certain circumstances of living, and where there is no vegetable supply obtainable.

By the present means of "cure" this material, as in the soup above referred to, is abstracted by the brine.*

5. *Lactic Acid* is another ingredient of perfect meat, and is found to be identical with that formed in sour milk, or by the decomposition of sugar, starch, &c. The acidity of flesh is in a great measure due to this acid, between which and phosphoric there is an equilibrium maintained. It is consumed in respiration, and is, therefore, a former of animal heat. When added in quantity to food it does not pass off by the kidneys, but disappears in the system, as shown by experiments.† "It plainly appears, therefore, that the lactic acid in the organism is employed to support the respiratory process; and the function performed by sugar, starch, and in geneneral all those substances which, in contact with animal matter, are convertible into lactic *acid, ceases to be an hypothesis.* The presence or addition of lactic acid heightens the flavour of meat. Again, it is also contained in the gastric juice, as one of its natural constituents"‡

By the present process of "cure" this lactic acid is abstracted, thus doing not only positive harm, by denying it to the gastric juice, but a negative one, in taking away so much natural aliment and carbon supply for respiration.

6. *Potash salts*, as seen by the analyses referred to above, are largely contained—

In Ash of Flesh.		*In Soup.*
Potash	40·20	35·42
Chloride of Potassium	14·81	14·81

In Raw Beef—Potash	9·599	per ounce.
In Salted " — "	0·394	

* *Liebeg's Chemistry of Food, p.* 135. † *Ib. p.* 103. ‡ *Ib. p.* 138.

Their uses having been before incidentally explained, it is only necessary to remark their quantity and obvious importance. These components are removed also by the process of salting,* and the occurrence of scurvy has been attributed to, and no doubt is, to some extent, owing to their absence.†

Certain other crystallisable constituents have been determined by the researches of Liebeg, such as kreatin, kreatinin, sarcosine, inosinic, (or the flavoring) acid of flesh, &c. These must be more or less destroyed by the ordinary "curing process."

Gelatine, usually supposed to be contained largely in flesh, though present in tendon, bones, &c., forms but a very small, and might be called accidental portion—in veal, not 1·578 per cent.; in beef, 0·6 per cent. Contrary to general belief, it is altogether *innutritious;* and here it may be well to refer to this very popular idea of the nutritive value of gelatine, as the latter substance is often supplied and purchased at a high rate for stores, either by itself in cases, or forming a large proportion, in weight and substance, of the tins of preserved meats, and served out to the men as food, and that of a non-nutritious quality, involving waste of money, space, and carriage, and still worse, being generally reserved for the sick comforts, is supplied at a high rate, *with injury instead of benefit.* The Gelatine Commission of Paris, under Magendie, 1841, pursued a series of experiments for a space of ten years, on gelatine made from Holland broth, bones, &c., and by different modes. Gelatine soup in abundance was supplied as long as the dogs, subjects of the experiments, would eat it; but by-and-by they refused, and though living amidst abundance of this soup, died of hunger, and in the same time as dogs of same weights, &c., who ate *nothing.* Again, dogs supplied with water and *no* food lived six, eight, or ten days longer than those supplied with gelatine only. But the instance of M. Jules Lecœur, who voluntarily went through a series of these experiments, is most complete. On the 22nd June, 1842, he took at mid-day *thirty-five* ounces of

* *Chemistry of Food, Liebeg, p.* 135. † Dr. Garrod.

gelatine, and three and a-half ounces of bread. He was more "*saturé que rassasié*"—more filled than satisfied; he felt uncomfortable, and was very thirsty. At three o'clock was hungry; at six he took twenty-eight ounces of gelatine and three and a-half ounces of bread; he felt more uneasy than before, was tormented with hunger in an hour, and at ten that evening, to satisfy his appetite, had to eat fifteen ounces of bread, though he had consumed the product of the evaporation of *thirty litres of bone broth*—about twenty-five quarts. So he continued for four days of experiments, suffering daily more uneasiness, having severe dyspeptic symptoms, perspiring much, and feeling weak. M. Donné also experimented on himself. After six days subsistence on gelatine, during which he suffered much from hunger, he had lost two pounds weight. Indeed gelatine, "so far from increasing, diminishes the nutritive value of food, as it does not disappear in the body without leaving a residue."*

Such an outline will suffice to show the variety of the compounds in meat, their relative amounts and importance, and demonstrate the necessity of inquiring how far the present modes of preservation fulfil *all* or *any* of the conditions requisite for a perfect material, hygienically as well as practically, and whether the method I have introduced does not offer a scientifically *correct*, *economic*, and *perfect* means of preserving meat with its natural elements, and even with those of vegetables artificially added. I will, therefore, briefly review the methods in use, in order to examine how far this is the case.

First, as to the "cure" by salting, in ordinary use. Salt, as an antiseptic, is so abundantly furnished by nature, is so economical and successful in effecting a "cure," that naturally it occupies the first place, not, however, *as ordinarily used*, without causing grievous injury to the meat—*hygienically by abstracting nutrition*, and *financially by losing weight*—as every one knows that meat by being salted loses in weight, though if left in pickle, occasionally after a time it is found to gain, not, of course, by

* *Liebeg's Letters on Chemistry*, p 444.

nutritive material, but by the admission of pickle. Liebeg has so fully investigated this subject, and shown the unsuitableness of such a mode of preservation, that he remarks:—

"Of 3 cwt. of meat by the operation of salting, 1 cwt. may be rendered useless to the vital process."*

And "it is universally known that in the salting of meat the flesh is rubbed and sprinkled with dry salt, and that where the salt and meat are in contact, a brine is formed, amounting in bulk to one third of the fluid contained in the raw flesh. I have ascertained that *this brine contains the chief constituents of a concentrated soup, or infusion of meat*, and that, therefore, in the process of salting, the composition of the flesh is changed, and this, too, in a much greater degree than occurs in boiling. In boiling, the highly nutritious albumen remains in the coagulated state in the mass of flesh; and in salting, the albumen is separated from the flesh; for, when the brine from salted meat is heated to boiling, a large quantity of albumen separates as a coagulum. This brine has an acid reaction, and gives with ammonia a copious precipitate of the double phosphate of ammonia and magnesia. It contains, also, lactic acid, a large quantity of potash and kreatine, which, although I could not separate that body from the large excess of salt, may be safely concluded to be present from the presence of kreatinine, &c. "It is now easy to understand that in the salting of meat, when this is pushed so far as to produce the brine above mentioned, a number of substances are withdrawn from the flesh which are *essential* to its constitution, and that it therefore loses in nutritive quality in proportion to this abstraction. If these substances be not supplied from other quarters, it is obvious that a part of the flesh is converted into an element of respiration, certainly not conducive to good health. It is certain, moreover, that the health of a man cannot be permanently sustained by means of salted meat, if the quantity be not greatly increased, inasmuch as it cannot perfectly replace, by the substances it contains, those parts of the body which have been expelled

* *Letters on Chemistry*, p. 448.

in consequence of the change of matter; nor can it *preserve, in its normal state*, the *fluids* distributed in every part of the body, namely the *juices of the flesh*. A change in the quality of *gastric juice*, and consequently in that of the products of the digestive process, must be regarded as the inevitable result of the long-continued use of salted meat. And if during digestion the substances necessary to the transformation of that species of food, be taken from other parts of the organism, these parts must lose their normal condition."* As the meat prepared for stores is afterwards packed in brine and headings of salt, a constant further abstraction takes place, so that the nutritive power already so low, is still further reduced, and probably exhausted; and the evils now attributed to the salt in the salted provisions are not due to its presence, but to the abstraction of the natural constituents, and to the injury done to those remaining. So far from salt being injurious *per se*, the natural instinct of animals shews the contrary. The experiments on animals by Bousingault, shew its advantage; and, strange as it may appear, the difference of food has no influence on its amount in the blood. The blood of a dog fed eighteen days on flesh had the same proportion as after feeding twenty days on bread. "Some cause is in operation, which *(as the proportion of salt in the blood* never goes beyond a certain limit) opposes the increase, as well as the diminution of its quantity. Consequently salt is not merely an accidental but an essential and constant ingredient in the blood, and its quantity is fixed within certain limits."* The very fact of the impossibility of drinking sea water, or the water of the tanks, where any of the sea water has unfortunately got admission, proves amply that the blood, having already its fixed amount, will not take in water containing salt disproportional to it. A simple experiment also puts it beyond question. "If we drink, fasting, every ten minutes a glass of water, the proportion of salt in which is far below that of the blood, after drinking the second glass the kidneys secrete a quantity equal to the first,

* *Chemistry of Food*, p. 135.

and so on; for twenty glasses we have nineteen secreted. But if we add some common salt—about one per cent.—no secretion takes place, and it is hardly possible to drink more than three glasses, shewing that the blood will not take in beyond a certain amount."*

It is plain, therefore, that the evil effects of a sea life, as scurvy, &c., which have been attributed to the taking in of salt, do not arise from it, but from the *incomplete nature of the meat;* for while in scurvy patients were subsisting on the same meat as before the attack, yet, by the addition of lemon juice, recovery took place without diminishing the salt, but supplying some elements contained in this and other vegetable products. *In its preparation as food* on board ship, of course salt meat of ordinary "cure" can only be prepared by boiling. There is *no variety;* and any nutriment it *may* possess after the "cure" and packing is taken away by the water in boiling, which *cannot* be used for soup, hashes, &c.

In the preparation of meat in tins hermetically sealed, the fluid necessary for the boiling is extracted from the bones which contain gelatine, as gelatine soup, and, of course, forms, and is intended to form, a considerable bulk and weight of the case or tin, but of a material valueless for nutrition, and even hurtful—as shewn by the experiments before related. While, from the inconvenience of carriage and expense, but a small supply of this meat, with a large proportion of gelatine, can be given as rations, and, by the great heat to which the flesh is exposed during its preparation, the chemical elements are changed. As the meat can only be served as thus contained in the cases in *bouillie*, it becomes disliked as an article of food, from its sameness and taste. Financially, the great loss entailed by cutting the flesh from the bone, and in small pieces, is a considerable objection, as is also the fact that expensive and local apparatus is required for the preparation, apart from the expense of the tins themselves.

Encrusting with different varnishes, so far has been

* *Letters on Chemistry*, p. 432.

found inefficacious, as the water contained within the meat causes decomposition,—while the difficulty of covering all the inequalities is very great.

Keeping the meat immersed in antiseptic fluids of course gives to the fluid all the nutritious materials above alluded to.

Packing in melted fat, though comparatively successful for small substances, on a large scale, would be both inapplicable and expensive, though the dried meat might be dipped in, or lightly covered with, such material for packing.

The method I have introduced *is not open* to these objections, either financially or scientifically. It is based on anatomical principles, taking advantage of the means nature has already used in supplying the circulating fluid to every *most remote and minute tissue* of the body. The difficulties hitherto were, that if the animal was killed as usual, the fluid introduced into the circulatory organs, capillaries, &c., would escape at the incisions in the vessels by which the animal was bled to death, and therefore not enter or saturate the flesh ; and if, on the other hand, the incision in the vessels was *not made*, and the blood not let to escape, it would remain in the capillaries, &c., coagulated or otherwise, and prevent the fluid entering, and so attaining the very parts required ; and once a small portion of meat would become decomposed, it would speedily propagate itself to the mass.

Brine and preservative fluids have been endeavoured to be forced into meat by atmospheric pressure, but without success ; and even still the method of "squirting" meat with a syringe, introduced into the mass here and there, is practiced with imperfect results naturally. For if the millions of channels afforded by the circulatory tree for reaching in the natural way all the flesh be not made use of, *no other humanly devised method* of doing so can be as successful. Yet a very simple, rapid, and most inexpensive method can be attained, by rightly availing ourselves of the means offered. The following is a brief description of the new process I have invented "The animal is killed by a blow on the head, piercing the brain and causing instantaneous death. The chest is

then at once opened, and the heart exposed. An incision is made into the right side of it : either the right ventricle or auricle,—and directly another into the left side (the left ventricle); the blood from the right side (venous), and from the left (arterial), immediately rushes out. When it has ceased flowing, a pipe is introduced into the incision in the left ventricle,—and so into the aorta, or great vessel leading through the body, *i.e.*, the trunk of the circulatory tree, and is there firmly retained. This pipe can be connected by a coupling with a stop-cock fixed to a flexible tubing, twenty to twenty-five feet long ; and this tubing communicates with a tank raised the height of the length of the tube, into which brine and a little nitre is put when well strained (about one gallon to the cwt.) The stop-cock is connected to the pipe in the aorta, and the fluid let on ; it will rush out at the incision in the right side of the heart, after traversing all the circulatory organs, in four or five *seconds* in sheep, swine, and such like,—and in nine or twelve *seconds* in oxen,—and in two minutes or so in the latter, and proportionately less in former, will have all run through—thereby clearing the vessels and capillaries, and preparing for the second stage, which is performed simply by closing the incision in the right side with a strong sliding forceps, and thereby rendering the circulatory system perfect, as originally—but with the vessels free and ready to receive the preservative fluid.

Into the tank above alluded to, the final materials to be used are introduced, and turned on as before, when rushing through and thus filling the circulatory tree, and the opening in the right side being *now stopped up*, the fluid over-distends the hitherto empty vessels ; the flesh surrounding the capillaries takes up the fluid in every part ; and it, as well as every tissue of the body, will thus be saturated with preservative fluid; whatever may be used, a few minutes suffices for the whole operation. It is no exaggeration to say that, with proper arrangements, an entire ox could be preserved with ease in ten minutes— and this without labor or anything worth calling machinery, and with nominal expense. The perfection of the process is *proved* by the fact, that when the animal has lain about three quarters of an hour to let the tissues be thoroughly saturated, it may be cut into pieces of suitable sizes—not too thick, to prevent a reasonable escape of the water by evaporation, and hung up at once to dry in a chamber with a good current of air, and a little smoke; or without it, if preferred; if possible, furnished with a revolving ventilator worked by water or steam. Failing these arrangements, it should be dried, if on board ship, by suspending in the air or aloft; if on land, in a chimney or some convenient situation dry and well ventilated.

The amount of drying, smoking, and size of pieces, and the appearance given to them, are of course matters of detail and taste, as well as are, to some extent, the materials. I use, as far as possible, those adopted in ordinary means, applied differently, but in accordance with the scientific view, of presenting a perfect material for the seamen and soldiers. I add such substances as will supplement those ordinarily obtained on land from the *vegetable kingdom*, and also improve the meat by adding to it as a plastic or nitrogenous element of nutrition, a carbonaceous or respiratory element in the shape of sugar, which at the same time improves the taste, gives softness, and acts as a preservative, while it supplies a normal respiratory material for forming lactic acid, the importance of which having been before explained, it is superfluous again to allude to; but it is necessary to notice that, as the meat prepared by my process is cut directly from the animal, it contains, of course, all the fat natural to it, being the normal respiratory food, "or producer of heat," combined with the meat, which is the plastic, *i.e.*, building-up food for the organs and structures, or "producer of force." For the latter purpose, as plastic food, 17 parts of lean beef equal 56 parts of wheat flour, 67 of rye flour, 96 of potatoes, and 133 of rice; while for the former purpose, of heat-producing, 1lb. of fat is equal to 2·4lbs. of starch, 2·5 of sugar, and 7·7lbs. of pure flesh.

By the addition of sugar, as I propose, a respiratory food of a very important nature is added, and therefore the meat for navy stores can be *still more* fitted for a substantial and life-supporting food for the sailor, who finds in the spirits, rum, &c. served out to him, heat-producing

foods, though "most costly materials of respiration, the same effect could be produced in the body by means of saccharine and farinaceous articles of food, at one-fourth or one-fifth the cost."*

As the sailor has at present sugar issued to him (the advantage of which experience has pointed out), and only objectionable from its taste, or when given in too concentrated a form, that is, too much at one time for the action of the stomach, surely it would be more economical and efficacious to add at least part of it in the meat.

Phosphoric acid, which, as before shown, is so important an element for the perfection of the functions of the body, as supplied in vegetable food, is more or less denied to the sailor. I propose to add it to the meat in certain small quantities—half an ounce or more to the cwt.—and in the form found in the flesh of fowl,† namely the monobasic or meta-phosphoric acid; as it, when prepared in this form, has the property of coagulating albumen. Its use is obvious by retaining this very desirable "force-producing" element in the flesh, at the same time giving a phosphatic supply, which, from the analyses above cited of the usual articles of food, is proved to be so requisite. As the albuminous material, when *fluid*, is very apt to decompose, its coagulation prevents this accident; and if it be determined afterwards to pack the meat in brine as usual, the coagulated albumen will be retained. It is to be explained that the addition of phosphoric acid is *not necessary* to my process, though to some extent useful as a preservative of the albumen; but I recommend it for the sailor and soldier in campaign, *as a dietetic addition* of great importance, in the absence of vegetables. Lemon-juice, at present issued at much expense, I believe only serves in making amends for the injury done to the meat in the ordinary process of "cure," and that in this way chiefly it acts as an antiscorbutic; for as the meat has lost, according to the estimate of Liebeg, *one third* of its properties for sustaining the vital process, and as a scorbutic patient, *though still* subsisting on this meat, with

* *Liebeg's Letters on Chemistry*, p. 470. † *Chemistry of Food*, p. 98.

the addition of lemon-juice will recover strength, it is evident the meat is injurious, not by its *positive*, but its *negative* properties; so that scurvy and various forms of debility arise from mal-nutrition, and not from the addition of salt, as has been so generally supposed; for even salt water has been given to scorbutic patients without aggravation of the symptoms. Though scurvy may not be seen in its intensity now as some years since, yet, the testimony of Dr. Macleod puts its existence, and that in an insidious form, beyond doubt. He states:—"Scurvy was the great destructive agent against which it was most difficult to cope, and which, though but little cognisable by its usual signs—though often carefully masking its presence behind some other ailment—*yet influenced every disease and touched with its poisoned finger every wound*."*

An inquiry into the symptoms will bear out this view. The most striking evidence of the change of the blood fluid, or the loss of that property it possessed of circulating in minute vessels without filtration, is shown by the well-known appearance of the bleeding gums, and the extravasations and blotches, that take place in various parts of the body, but can be explained by the want of the proper circumstances for sustaining the electrical influence described by Liebeg; for if the phosphoric and lactic acids and the potash salts be wanting in the muscle-juice, and the phosphate of soda in the blood, the necessary conditions cease, and the filtration of the blood fluid and colouring matter takes place throughout the body.

The urgent symptoms of want of respiratory power shown by the difficult breathing, dusky hue of skin, fainting, rapidity of breathing, &c., *though the lungs are remarkably free from any disease*,† can only be explained by some want in the blood for taking its part in the process. As the machinery, if we may call it, of respiration is perfect, there must be a defect in the circulating material. As the great agent in the circulation, the phosphate of soda of the blood, has not been supplied, there is no means of carrying the carbonic acid and supporting respiration

* *Macleod, Notes on the Surgery of the Crimean War*, p. 69.
† *Library of Medicine*, vol. v. p. 83.

and animal heat. Therefore, scurvy is observed to come on sooner in cold countries, or where damp clothes are worn, and where the men are on limited rations, under circumstances where the respiratory process should be particularly perfect. The muscular debility remarkable in this disease follows from the want of the proper supply of circulating fluid and chemical constituents. All the symptoms, in fact, can be traced to the want of the natural elements which have been abstracted from the meat. In order to test this idea, and as the analyses given in books supplied no information, at my request lemon-juice from the admiralty stores was analysed by Professor Galloway, Museum of Irish Industry, Dublin, the result showing the existence of important constituents not before enquired for, but of well-known utility.

Analysis made April, 1864, gave, in one gallon of lemon-juice, phosphoric acid equal to 91 grains of anhydrous acid, or 458·5 grains of ordinary phosphate of soda.—The potash was not estimated.

Two analyses made in October, 1864, gave 71 grains of neutral or diphosphate of potash per gallon, and, in addition to this, about 110 grains of potash in the form of other salts.

The Potash Salts I add by my process, as nitrate of potash, phosphate of potash, or chloride of potassium. The former I believe to be most suitable for general purposes, giving colour to the meat.

The other crystallisable substances, *kreatin*, &c., enumerated before, are of course retained in their natural conditions, as no means are taken to remove them.

The addition of spices—pepper, cloves, and condiments; also such flavours as may be desired, lactic acid itself, saur krout, &c., can be made at a very trifling expense, in this way pleasing all tastes and requirements.

Though any preservative fluid can be infiltrated, I prefer to use that in most general use, such as pickle with sugar, saltpetre, nitrate of soda, phosphoric acid, spices, &c. Pickle and saltpetre or nitrate of soda suffice for the mere cure, so that *an entire ox can be preserved* for less than one shilling; sheep, swine, &c., for a few pence. If the other materials, as I recommend, are added, they of course add to the expense, but are so much more important and agreeable food,—therefore a saving.

The fluid can be used either cold or boiling, which latter state I avail myself of in some circumstances where, for instance, it is determined to pack the meat in brine afterwards. The boiling fluid, on admission to the flesh, coagulates the albumen and gives a "set" to the meat, so that this albumen cannot separate from it in the casking.

When the meat has been dried and smoked according to taste, it can be packed in cases of sheet iron, in barrels, or tins, either protected from any accidental moisture which would harm them, by dipping each piece in melted fat, so as to make a coating, or by packing in dry saw-dust, either alone, or, which I prefer, with powdered charcoal mixed in equal parts. This packing material should be sufficient to thoroughly cover the pieces.

When about to be used, the meat should be washed to free it from the packing dust, and steeped for a few hours in water, or not, according to taste; then prepared as ragouts or hashes, with pea-meal, flour, and such materials as may be had on board ship. By the present system the meat, already deficient in nutritive power, is boiled, and the fluid *thrown away;* whereas the "hung" or "dried" meats can be prepared in ragouts, hashes, soups, and roasts; so that the fluids containing the soluble elements would be taken along with the meats. If for roasting or grilling, the meat may be steeped a few hours in cold water,—and if for making soup (which can be done even for invalids), after a little steeping it should be cut up in very small particles, and so gently heated—such farinaceous matters being added as are accessible. In fact these meats admit of being prepared for food in any way the ingenuity of the "cuisine" may determine, thus of course presenting advantages not to be obtained by any other known process.

A very important convenience also is attained, that the

meat, not containing the large amount of fluid originally in combination, can be carried in small bulk. Each man could take with him in perhaps one-half or one-third the bulk, the amount of *nutriment* contained in the whole; and again, this meat can be eaten (if circumstances require it), without cooking.

Apart from the economy and efficacious nature of my process, there is presented to the authorities this very great advantage, that nothing is done *in secret.* All the stages of the process can be inspected by the officers appointed, so that the health of the animals and the wholesome quality of the meat could be certified; while meats can be prepared at all seasons, and equally well in summer and autumn, when the animals, having recently been fed on the fresh grasses, are nearer to their natural condition, and their flesh better food, being supplied with the earthy salts, &c. The price is also less in the summer and autumn,—for in winter, by the great demand on the market for the "curing" months, the price is considerably raised. On the other hand, there is no doubt as to the injury done to the meat in the ordinary means of "cure;" and as to the preserved meats in tins, there is no means of knowing the condition or health of the animal (though of course the known respectability and high name of manufacturers is more or less a guarantee); while, from the large amount of gelatine soup in the cases, much expenditure is made on a valueless and hurtful substance, though one which, from popular impression, is believed to be the reverse.

A *vast advantage,* and one *altogether unprecedented,* presents itself in the use of my method, namely, that on the arrival of a ship at port, meat can be prepared and preserved on the spot or on board, and in a *few hours* a stock for stores furnished, as the apparatus is portable (not costing more than a few shillings), the materials always to be had, and also the necessary height or pressure. In hot countries the meat may be drying, and in process of preservation, half an hour or so after the death of the animal. If it is desired to be kept drying slowly, it should be suspended in pieces between decks,—or if to be dried quickly, it might be suspended either aloft or in an extemporized drying shed.

From the description already given, it is plain that the labor required is nil.

I would beg *most strongly* to urge the advisability of having certain officers and men on board each ship instructed in the method, and to practice it wherever animals may be found; as the *necessity for carrying a large store of provisions* would be thus obviated, while a superior and better tasted material could at all times be prepared at an extraordinarily cheap rate, and even in countries where decomposition usually sets in after a few hours.

I would, in conclusion, remark, as to the process itself, that success in some circumstances is attainable without the use of the first stage, *i.e.*, of washing the circulatory apparatus; but it is a most desirable preliminary stage, as I have found by experience, and therefore I strongly recommend it.

Notwithstanding the simplicity and rapidity of my process, though based on anatomical and correct principles, of which I have endeavoured to give an outline, I am, from experience, both in England for the admiralty, and in France before a commission appointed by government, so thoroughly persuaded of its efficacy, its adaptability for use in all weathers and climates, and the perfection of its results, that I am solicitous of the fullest trials and enquiry in every way by the authorities; though at first sight prejudice, or the natural objection made to any innovation or change, may present difficulties. I am sure that experience and enquiry will satisfy both as to the mechanical applicability, and scientific correctness of the method; while as to details of flavors, appearances, and size of pieces, experience alone on an extended scale of trial can decide what may be the most generally suitable, convenient, and pleasing.

In countries where animals are all but valueless, and where labor is scarce or unavailable, my process is peculiarly valuable, and will directly, I expect, be the means of introducing here a suitable, wholesome, and agreeable meat for the million, at a most reasonable price, and containing all the nutritive properties.

In January and February last I was allowed to prepare fifteen oxen for the Admiralty at Deptford. In twenty-four hours some of the meat was packed as usual in barrels, and some pieces put to dry in the most convenient situations at the victualling yard. With part, a very great heat in the biscuit-drying loft, (about 120°,) was used successfully, and the drying accomplished in a few days. Other pieces were hung in the cooperage chimney, and dried after a few weeks time. By the report of the officers, both these meats having been packed dry in ordinary barrels till August 30th, 1864, when opened and examined at that date were pronounced perfectly preserved, showing that so far, after the lapse of seven months, the material is sound, and capable of preservation through the hot summer months, in barrels, and that without the erection of any special apparatus, in the first instance, as would be desirable for the drying.

In June and August last I operated before a Commission at Rochefort, appointed by the French Government, and prepared both oxen and sheep, in the height of a continental summer, with perfect success, though with but extemporized apparatus. When dried some time, the meats were prepared as ragout, beefsteak, chop, the latter of course grilled. Nothing could be better, particularly than the beefsteak. Soup was also prepared of excellent flavour and appearance, thus showing the value of this material for invalids, while from the artificial addition of sugar, phosphoric acid, potash, &c., it is manifestly particularly suited to the requirements of the sailor—invalid or in health.

Most important testimony in favour of my method has been given by Dr. Parkes, Professor of Military Hygiene, Army Medical School, in his work on Practical Hygiene just published. At page 215 it is remarked, with reference to the process, "This is an excellent plan, and will undoubtedly supersede the old system;" and again, under article "Sieges"—"If food threaten to run short, the medical officer should remember how easily Dr. Morgan's process of salting meat can be applied, and in this way cattle or horses which are killed for want of forage, or are shot in action, can be preserved."

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NATIONAL HEALTH AND WEALTH.

Some apology may be needed for my subject and for myself, as a clergyman, thus writing on it. Its importance must excuse its unpleasantness. And for myself, the position of my house, and of the town of Dorchester, on a chalk stratum, honeycombed, as I suppose the site of all such towns is, by cess-pools, the works in progress under the Board of Health for draining the town, and the painful circumstances of a portion of my parish already before the public, have compelled me to devote hours to this subject, which might well have been given to recreation after the arduous duties of my ministry. And, if I have thus been led to the discovery of a mode of remedying the evils both of cess-pools and of water-drainage, a mode by which the enormous nuisances of both systems can be effectually relieved, by which such sources of sickness and disease can be cut off, by which the vast sums spent on town-drainage can be saved, and the extravagant waste occasioned by it prevented; then, to be silent because of the nastiness of the subject would be false delicacy, and still more would it be a neglect of duty towards my neighbour and my country. I am one of those, moreover, who see a marked action and re-action between moral and spiritual evil on the one side, and physical evil on the other; and who, therefore, regard it as quite within the province of a clergyman to bestow a portion of his time and attention on such evils and on their remedy.

The cess-pool and privy vault are simply an unnatural abomination. People boasting of civilisation and cleanliness are accustomed to it, and therefore they still to a great extent endure such a mode of removing filth. With the one object of getting offensive matter out of sight, they form so many treasure-houses of bad smells and noxious gases, so many sources of disease and death; and, at the same time, waste the most natural and effective fertiliser of the soil.

The water-closet, used in connection with the cess-pool, has only increased these evils. It affords convenience, and in some cases relieves offensive smells; but, in many others, these smells are rendered even more offensive, and the evil of noxious gases increased and brought nearer home.

While, again, in the system of the water-closet combined with water-drainage, these evils are only shifted: they cannot be said to be remedied. The individual house and premises may be relieved from the presence of filth, but it is at the expense of spreading it through the sewers of the town, and of sending the noxious gases through the gully-holes into the midst of the population; those gases, too, being rendered more noxious by the spontaneous fermentation of ammoniacal substances when mixed with water. The town may still in various ways be relieved; but it is at the expense of the neighbourhood through which the stream or river that receives this sewage may pass. And while the sums spent on this system are vast, and the waste of valuable manure by its means almost incalculable, this too much boasted remedy already calls for the application of remedial measures! For, let any one look first at these facts stated by the Royal Commission on Town Sewage in their Preliminary Report:—

1. "The increasing offensiveness of the Medlock and Irwell at Manchester, of the Mersey at Stockport, of the Tame at Birmingham, and of many other rivers, proves that a *national evil* is fast growing up which *demands immediate and serious attention*. The last-named river, ... a small stream in itself, may be said, without exaggeration, during dry seasons to contain at Birmingham as much sewage as water, &c., &c."

"The Thames, which at a high point is supposed to yield a supply of pure water to London, before it reaches the recently adopted point above the tidal influence receives the sewage and drainage water of towns and villages containing more than seven hundred thousand inhabitants. In the great majority of these places little or nothing has yet been done with a view to the improvement of the public health: but looking *at the rapid extension of drainage operations*, it will readily be conceived that in the absence of general measures to prevent the pollution of rivers, *the state of the Thames will soon become seriously affected even by the sewage of those places alone*."—pp. 9, 10.

From these, and similar facts, with further details of their effect on the health of such towns, the Commissioners arrive at several conclusions; let serious attention be given to these two:—

1st. "That the increasing pollution of the rivers and streams of the country is an evil of *national importance*, which *urgently demands the application of remedial measures*." . . . .

2nd. "That this evil *has largely increased with the growing cleanliness and internal improvement of towns as regards water supply and drainage*; that *its increase* will continue to *be in direct proportion to such improvements!!* and that, as these improvements are yet very partial, the influence of sewage, *already very sensibly felt*, is *extremely slight* as compared to what it will become *when sewage and drainage works have been carried into full effect.*"

A cure, such as water-drainage professes to be, for larger evils, itself so soon and so urgently demanding remedial measures! *Growing cleanliness* and *sanitary improvements* the sources of a largely *increasing national evil!* There surely must here be something wrong—something that will admit of no palliative. And one wonders that the very next conclusion to those given above was not this, That the system which originates such an evil must be changed altogether; that, after all, water is not the great purifier of our houses, and that the great object of our endeavours must be, not to remedy the evil which water-drainage originates, but to prevent its formation, or to cut it off at its source. *And this can be done.* Every house, excepting in some of the most wretched and crowded parts of large towns, may, with ease, and without public works, and without offence, deodorise and remove effectually and completely its privy soil, and all greasy matter. And one of the best sanitary laws which could be enacted, would be that which should forbid, under heavy penalty, the erection of any house or cottage in town or country without room or provision (and it would not be large) for this purpose.

But what is the means of effecting this? What this new discovery? Let none be offended because of its simplicity. Let none meet it, as I have known a somewhat similar proposal met, with the feeling, "Then what fools we shall all look with these miles of drains, which have cost millions, and nothing, or almost nothing, for them to do." Let the method which I am about to propose, which is now one not of theory and reasoning, but of experience, be fairly looked at, and it must be accepted, first, for its very simplicity, then for its effectual prevention of nuisance and evil, then because of its application to detached houses in the

country, and in any situation, as well as to towns and to houses by rivers and streams, and lastly, for the very important consideration of its saving to the country millions of tons of most valuable manure, and at the same time preventing the enormous expense of drainage and drainage improvements.

The great, and in most cases the only, agent in this mode, is dried surface earth, the extent of the capabilities of which, both for absorption and for deodorising offensive matters, I accidentally noticed about seven months ago, and the truth and correctness of which observation has been proved by daily experience. I have also ascertained that various subsoils, especially clay and silicate of alumina, are equally efficacious as deodorisers, and the latter produces a more valuable manure.

The power and efficacy of this agent will, however, be best understood and believed, if I give a simple narrative of what the use of surface earth of my garden has done for my own family, averaging during the period of its use fifteen persons daily.

Eight months previous to this period, under a strong impression of the evils either occasioned, or likely to be occasioned, by the vault or cess-pool on my premises, and feeling it to be a nuisance to my next neighbour, as well as to myself, I filled it up with earth, and ever since I have had everything that would otherwise have gone into it received and removed in buckets. And even this mode of removal, though offensive in idea, has proved far less so in reality, than even a very small portion of the evils it is intended to remedy. At first the contents of these buckets were buried in trenches about a foot deep in my garden; but on the accidental discovery that in three or four weeks, after being thus deposited, not a trace of this matter could be discovered, I had a shed erected, the earth beneath it sifted, and with a portion of this the contents of the buckets every morning mixed, as a man would roughly mix mortar. The whole operation of removing and mixing does not occupy a boy more than a quarter of an hour. *And within ten minutes after its completion neither the eye nor nose can perceive anything offensive.* This was the first observation I made. The next was this, that when all the earth, *which did not exceed three cartloads*, had been thus employed, that which had been first used was sufficiently dried to be used for the same purpose again; and it absorbed and deodorised the offensive matter as readily as at the first time. And so singularly does this capability continue, that a portion of it has been used for the *fifth* time for the same purpose; and thus all that offensive matter, which otherwise would have been wasted in the vault, a nuisance to my house and the neighbourhood, and a source, it may be, of sickness and disease, was converted into a mass of valuable manure, perfectly inoffensive both to the eye and nose. I have taken many persons to see it without previously acquainting them with its nature, and not one has guessed it. All have declared it to be wholly without offence. Two have handled and smelt that in the afternoon which had been mixed in the morning, without being able to discover its nature. And more than this, I have the same day submitted some to strong fire-heat; and that which, unmixed with earth, would under such heat have been intolerable, in this mixed state emitted no offensive smell whatever.

Again, I have found the efficacy of this dried earth equally great when applied in sufficient quantity to the horrible refuse of a slaughter-house, and that, after the earth had been previously mixed three times with the contents of the buckets. A barrow of this earth was sufficient to absorb and deodorise a bucketful of the refuse.

Here, then, in the roughest and rudest mode of employing

it, is an agent of a most important character in the work of cleansing houses and towns. Its advantage over water for such a purpose is complete. Water is only a vehicle for removing it out of sight and off the premises. It neither absorbs nor effectually deodorises. It rather—both in cesspools and in sewers—aggravates the offensiveness by the fermentation which soon sets in, and is often repeated; and further, it dilutes and wastes a most valuable manure. Whereas dried surface earth both absorbs and deodorises the most offensive matter, and that almost instantaneously; and under such circumstances as those narrated, it seems to preserve its full value for agricultural purposes.

After the first edition of this pamphlet was in type, my attention was called to two papers, by Professor Way, in the "Royal Agricultural Journal," on "*The Power of Soils to absorb Manure.*" The very interesting observations and experiments detailed in those papers were directed to a different object from mine, namely, the cultivation of the soil rather than the deodorising and removing of offensive matters. But the power or capability of soil observed by that gentleman, and by the Rev. A. Huxtable, and Mr. H. L. Thompson, to whom he refers, is clearly the same as that which, from a different point of view, and especially *in its repeated action*, had thus been observed by me. This *repeated action*, however, so far from having been previously known, was, on the appearance of my pamphlet, doubted by one of those parties. The correctness of my observations and experiments was questioned; and a gentleman was sent to inspect the mass of manure spoken of above. He found, however, the last portion of it used for the fifth time, lying as it was left at six A.M. that same day. He went into the shed at one P.M. He handled it, and smelt it without being able to perceive the slightest offence, and even took back with him, in his carpet-bag, about one pound weight of it in a deal box, with a loose cover tied round with a string.

Now, I wish it to be observed, that it is this capability of repeated use and action which renders the employment of earth so feasible for the removal of offensive matters, especially in towns: first, because of the much smaller quantity of earth required for a given time; secondly, because of the value of the manure being thus compressed into a lesser bulk; and, thirdly, because of the expense and trouble of carriage and removal being thus proportionably reduced.

With reference to the value of the manure which may thus be produced, I have, since the publication of my first edition, received much information, and made a few experiments, some details of which I now give.

One of the most intelligent men of business in the south of England, well known for the extent and correctness of his statistical information, on reading my pamphlet, said to me: "When you reprint it, show the public what they are throwing away—and spending millions to throw away—and the greater and most valuable part of which this method of yours will save."

The substance of the statements and calculations he then gave me was as follows:—

It is the result of the large, long-continued, and thoroughly practical experiments of intelligent farmers, that one-third of the value of the corn with which they feed their cattle goes on to the ground in the form of manure. Let this fact be applied to human beings congregated in a town of 7000 inhabitants; and take, as the average value of the meat and corn food consumed by each individual, 2*s.* a week, or 5*l.* a year. Instead of one-third of the value of this for the manure produced, take, if you please, only one-fifth—or 1*l.* a head. That town, then, on the present drainage system, is

throwing 7000*l.* a year into the river, and the metropolis throws no less than 2,500,000*l.* into the Thames, and is now expending 3,500,000*l.* on works that shall throw it away more completely in the marshes of Erith.

It has been doubted by some, but without any assigned reason for their doubts, whether the earth absorbing and deodorising the soil at once, and before fermentation sets in, receives and retains the value of the manure. The luxuriant growth of vegetables in my garden would be a sufficient reply to such doubts; but that, as a large quantity of liquid manure from the house is also used, some might not be satisfied with this, especially as the scale of experiment is very small. It would not be enough to state, that out of a small patch of this garden, with no other manure applied at the time than the recently deodorised soil of the house, and without any help from glass, I have, in the month of September, pulled good-sized radishes in three weeks from the time of sowing the seed. But I think the following experiment, tried last year, will prove a satisfactory settlement of any such doubts. A farmer in my parish put in some Swede turnips late in the spring, *with some of the earth* mentioned above, *as having been used five times in removing the soil of a family for seven months, averaging, during that time, fifteen persons.* It had lain in the shed full seven months after being used. The quantity applied to the ground was one cwt. to a quarter of an acre. Equal quantities of superphosphate were applied to fifteen equal spaces of ground. The crop, though injured by the vast growth of weeds during the late rainy summer, was one of the best in the neighbourhood. And though all that I had looked for was that the piece manured with the mixed earth should be as good as those which had received the superphosphate, yet through the whole of their growth there could be no doubt as to the superior healthiness and strength of the plants grown in the former; and *on pulling them, the roots of them weighed full one-third heavier than the others.*

Now, from a town of 7000 people might be procured, with ease, and without offence, and with great advantage to the health, comfort, and morals of many, at least 3000 tons of such manure a year. And a company allowing even 10*s.* a head for the purchase of the soil from the inhabitants, and 10*s.* a ton for carrying the earth in and out and drying it, and then selling it at 3*l.* instead of 6*l.*, 7*l.*, or even 8*l.* a ton, the price of superphosphate, or double those sums the price of guano, would make a profit not to be despised. In a communication to the "Gardeners' Chronicle" (January 26, 1861), I put the purchase of the soil at 2*s.* 6*d.* a head, and so low a price as this numbers of the working classes in towns would gladly accept. There is no sufficient reason, however, that it should be so low. But set even this as gain or help against the increase in rental, which may be occasioned in some places by the drainage system, of 6*d.* or 9*d.* a week on the poorest dwellings, and how great in this case is the advantage!

I give another instance of what may be saved or gained by the public. A county gaol may have an average of 150 prisoners and officials. The water-closets for their convenience may be 60 in number, and the expense of keeping them in order is not less than 50*l.* a year. Now, an apparatus for an earth closet—for which a patent has been obtained, and of which I will speak presently—is so simple in its machinery, that 60 of them might be kept in order for less than 5*l.* a year. And if to the 45*l.* a year thus saved the value of the manure, according to the calculation above, be set at 150*l.*, there would be a gain to the county of about 200*l.* a year. Extend this to barracks and to hospitals, with their 200, 800, or 1000 inmates, and do I err in adding

wealth to health in my title, as expressing the result to the country of the general adoption of the plan here proposed? Substitute, moreover, in the case of barracks that—which this plan renders perfectly safe and practicable—a sufficient number of separate closets in the immediate proximity of the sleeping-rooms and stables, instead of the offensive crowding of such places, erected, because of their offensiveness, at a great distance from the buildings, and, I might add, to *health and wealth, comfort and decency.*

I cannot allow myself space to point out the indication of this property of surface earth being the provision, which God has appointed in the nature of things for this very purpose to which I propose to apply it (Deut. xxiii. 12—14.) I go on to show how the rough plan I at first adopted may be modified and applied to the dwellings of the various classes of society, both in the country and in towns. My mind turned first to the cottage of the country labourer, both because here the application would be more easy and simple, and because that frequently in those cottages, as well as in the country houses of the more wealthy, the sources of evil in the cesspool or vault are in proportion as fruitful and as fatal as they are in towns. Again, a supply of manure, which often it is so difficult for the labourer to procure, would thus be readily and abundantly supplied. And to this consideration few owners of gardens, whether small or large, will be quite insensible. The present vault, then, in the cottage garden should be filled up. In its place, there will be an inclosure of brick or stone, under the seat. Its square dimensions should correspond with those of the seat. The bottom, which, to preserve the full value of the manure, should be watertight, should be three or four inches below the level of the floor of the place. At the back of this inclosure there should be an opening with a door; and to admit of this, the brick or stone work should not on that side rise more than six inches. Through this opening the earth is introduced in such quantity, and removed as frequently, as is found necessary. Several who have for some time adopted the plan, have used the coal-ashes of the house for the purpose. But though there may be some convenience in this, and perhaps a little saving of labour, the manure thus produced is not so valuable. On one side of the privy there should be a rough shed, opening in the same direction as the opening of the inclosure beneath the seat. It should be capable of containing and keeping dry a cartload of earth for daily use; and on the other side there should be a similar shed, opening in the same direction, into which the earth, having received the soil, should be thrown day by day for the purpose of mixing and drying. When dry, this would be used again, and the purposes of the two sheds be reversed. And by thus repeatedly using the earth and shifting it from shed to shed, both the specific value of the manure is increased in proportion to the frequency of the operation; and one load of earth will be found sufficient for five person, certainly for six months, and I believe for twelve. This is the simplest, but by no means the least offensive, mode of application of this remarkable agent.

Another mode suitable for the interior of houses, and for which, as I have said, a patent has been obtained (1860, No. 1316), is that of a closet, whether fixed or portable, in which either surface earth or subsoil is used instead of water. Commodes also are fitted up in the same manner. As the back to either of them there is a box containing sifted and dry earth, which box communicates with the pan through a pipe at a certain angle; and the opening of this pipe is at such height above the bottom of the pan as to regulate sufficiently the quantity of earth used. The bottom, in the simplest form of construction, moves hori-

zontally by lever and spring. When at rest it is covered with about one and a half pint of earth; when moved, it is freed from all that is on it by the pan acting as a scraper. In a portable closet or commode, the contents of the pan fall into a bucket which, with a cover, can be carried away without the slightest offence. In the case of a fixed closet, it falls through a shaft into any receptacle which it may be thought fit to provide, whether within or without the house; in which also, by the simplest mode possible, it may be mixed so as to be perfectly free from offence both to the eye and nose; and from hence it can be removed either for use as manure, or to be dried and used again. One of these has been used by a clergyman for the last three months. It is in a position not three yards from his dining-room door. Two persons have used it—the earth has not been removed from the receptacle oftener than once a week—but from its use no offence has ever yet been experienced. Another has been used in a bedroom for seven months, with the same satisfactory result. Wherever there is sufficient space for drying a large quantity of earth, the atmosphere will, after it has been mixed, dry it sufficiently, especially under a roof of glass. But if, in consequence of want of room, or of the small supply of earth, artificial heat be required, the recently *patented vapour-fed stove*, or *cottage range*, by a proper arrangement of its flue, would dry enough for several hundred people, with about two pennyworth of fuel daily.

The introduction of earth for this purpose into houses, whether in town or country, in the proportion of one ton to every five individuals, for twelve months, would be as cheap and easy as the present large supply of water. Wherever it is necessary to pump the water, the introduction of earth is far easier than that of water. And if the Patent Vapour-fed Grate, or the application of that invention to an ordinary kitchen range, should be used as the means of removing dish-water, so much fuel would be thus saved,* that the carrying of this load of earth might be reckoned as nothing; while the removal of it from the premises at the end of twelve or six months, or oftener, would be as easy and inoffensive as the removal of coal-ashes. And the facts stated above will show, I think, that manure companies would soon be ready to purchase it.

The arrangement for the removal of the stable manure of the Cavalry Barracks at Dorchester (and I suppose that similar arrangements exist in other barracks), will serve to illustrate the readiness with which farmers may be expected to supply earth for closets, and the comparative facility of its removal. The farmer supplies the straw required in the barracks free of all charge, and on the sole condition of receiving in return the manure made by it. For every load of straw, he in general receives back three loads of manure. Now that load of straw would sell for 30*s.* Add to this value, then, the wages of a man and boy, the use of horses, and the wear and tear of waggons, and each load of manure must cost at the least 12*s.* And I once convinced a farmer, who was rejoicing in having obtained the privilege of thus supplying straw to one wing of these barracks, that in the carriage of the straw to the stables, and of the manure from thence to his fields, and in manuring with it 100 acres at the rate of ten loads to an acre, he would expend more than 500*l.*, and that three horses would have to travel, in performing this task, 2000 miles. Now, one load of the manure, made in the way proposed in this pamphlet, would be equal to 15 or 20 of stable manure, and the earth, or subsoil, might in general be supplied for it at no other cost than that of labour and carriage.

* See Advertisement at the end of the pamphlet.

I ought here to add that, in the country, or on premises in a town, with even a good-sized court, almost all the liquid sewage may be removed by means of earth, and in a way similar to that proposed for the removal of privy soil from cottages. And in the cases in which much dish-water is produced, the manure thus made will be little, if at all, inferior to the other. There should be a dish-shaped tank, capable of containing one or more barrows of dried earth, according to the size of the family, and to the frequency or infrequency of its removal for drying. It should be protected from the rain; and if the earth be removed before it be saturated, there will arise from it, though close to the house, neither offence nor injury. A covered shed for the purpose of drying the earth would be convenient.

It may be observed that the drying of almost any quantity of earth mixed with soil, in proportion to the size of the house, might be effected in the cellar without any inconvenience even from steam, which in the use of the vapour-fed stove may be all passed through the fire. And as the stove may at the same time be used for other purposes, the expense of thus drying the mixed earth might be set down as very trifling. Moreover, as this drying would be effected chiefly if not entirely by the steam from the boiler of the stove, the value of the manure being thus uninjured, this expense would be more than covered.

But the efficiency of this agent will be most apparent, though not really greater, in public than in private establishments, and especially in the removal of *a great public nuisance, and the relief of a great public want;* to both of which it fully opens the way. The nuisance is the horrid offensiveness of urinals at railway stations. The want is that of urinals and public closets in London and our large towns. Indeed in almost every town and large village the erection of these would greatly promote habits of cleanliness and decency. As to railway stations, I am persuaded, in the first place, that by the adoption of either the vapour-fed stove or grate, in proportion to their size, for the better warming of the waiting rooms, full 50 per cent. (in some cases, as at the King's Cross station, 200 or 300 per cent.) would be saved to the company in fuel; and in the next place, that by the proper use of dried earth in the urinals and closets, while these would thus be kept perfectly free from offence, the value of the manure saved would be great.

And as to urinals and public closets for London and large towns, if by the mode stated above the mixed earth be dried at a proper temperature, and the full value of the manure be thus preserved, then by a proper selection of sites a company might fully relieve this want, not only without offence, but with a vast pecuniary profit. One of the most important features of the plan is this, *that it is as easily applicable to the most wretched and crowded parts*, where humanity most loudly demands such relief, as to any other. And if either by the Metropolitan Commissioners, or by a company formed expressly for the purpose, there should be undertaken, in addition to a sufficient number of such establishments, the removal by the same process of the soil of barracks, hospitals, schools, and other public institutions, far more would be done to relieve the Thames nuisance, and the sewer and gully-hole nuisance, than can ever be effected by any plan hitherto devised—far more to prevent disease and promote health. A million of the population of London might soon and easily be thus reached, with an outlay, I believe, of far less than a million sterling, returning a gross income, too, of nothing less than that sum. If the working expenses be put down even at half of this, then a profit might be looked for of half a million, with increased relief to health and morals, which, to say the least, is something better than

£3,500,000 spent on works which shall make no return whatever.

I have dwelt thus largely on the money view of this question. And my especial reason for it is this. Public works press more heavily on the working classes than is commonly known or imagined, and while relieving or removing one great evil, they may occasion or aggravate others. Of this Boards of Health and their promoters have not in carrying out the drainage system been sufficiently considerate. Whilst honestly endeavouring to relieve a confessedly great source of physical and moral evil in the improper or insufficient mode of removing excrementitious matter, they have not foreseen or considered how the drainage rate increases the rent of the working man. The ordinary allowance for rent out of a man's income is 10 per cent. But in the case of many a working man in this town the rent he has to pay is 25 per cent., 2*s.* or 2*s.* 6*d.* out of 9*s.* or 10*s.* a week; and to this a water and drainage rate may add 3*d.*, 6*d.*, or 9*d.* a week. And as wages do not increase in proportion, the necessity is thus originated or increased of taking in lodgers, and generally without regard to character, in order to pay the rent. The impure air of crowded rooms become thus another or an increased source of physical evil; and the moral evil occasioned by the larger crowding of persons into sleeping rooms without distinction of sex, age, or character, is far greater than that, the remedy of which is sought in the drainage system. It is too late, perhaps, to correct these evils in the metropolis and in other places into which this system has been introduced. And yet, from what has been stated, much may, I think, be done to relieve these evils there. But on this ground, and on behalf of the working classes, a warning voice may well be raised against the water system of sewerage in those towns in which it has not yet been adopted. And if the principle and plan which

I have developed be correct, the inhabitants of such towns should be further told that the scheme for the general adoption of that principle and plan in any particular place requires no great and expensive public works, such as large and extensive sewers; it may be quite experimental in its commencement; gradual in proportion to success; involving therefore no great risk; and, if successful, increasing in every such place the wealth of the community, without aggravating the poverty of the poorer classes. Let me add to this that it is the only plan which can with any degree of economy and comfort and safety be adopted by all classes in detached houses and villages, or in towns which are so situated as to render the water-sewerage system either inefficient, as far as it goes, or even impracticable. In Brighton and Weymouth, and other watering places for instance, what outlet for filth can you get by means of water without spoiling the bathing? In towns situated either, as some places in the neighbourhood of London, too high for a supply of water, or as those in the fen districts of the country, with too large a supply and no outfall, how can water be used for the purpose of sewerage? or, if used, how can injury and increased nuisance be escaped? Or again, if recourse be had to the system of tanks, force-pumping, and irrigation of the land, how enormous for this the outlay! How almost impossible to make men pay even a small sum for that of which you are glad to get rid, and how vast in that case the increase of burden on the working man! Now in all such places the earth system is just as available and efficacious as in any other; and the disposal and sale of the manure not being necessarily contingent on the use of it in the immediate locality, it would not be sold at a disadvantage. In such towns and situations, then, unless the evils and abominations of the vault and cess-pool are to be continued, the earth system must be adopted.

I cannot conclude without pointing to the immense benefit and comfort to be derived from the adoption of commodes on this earth-principle in sick-rooms and in the wards of Hospitals, and in connection with the large Dormitories of Public Schools, or of Unions. If used also as urinals in the wards of Hospitals, or in rooms in which numbers sleep, very great relief by the prevention thus of the spontaneous fermentation of urine would be afforded to the impurity of the air in such rooms. And in connection with this, I may state, that more than one medical man, of large practice and experience, when looking at my principle and plan, from his own point of view, has remarked, that if the scheme could be generally adopted, and one half of the probable results should be verified, more would be effected by it for the prevention and check of disease and sickness, and for the improvement of health, than Jenner has effected by the discovery of vaccination.

FORDINGTON VICARAGE,
April 2, 1861.

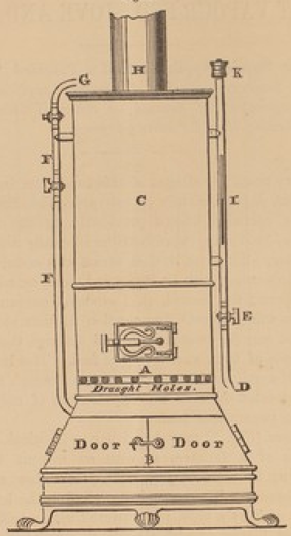
PATENT VAPOUR-FED STOVE AND GRATE.

THESE are Special Applications of a Patented "*Invention of Improvements in Apparatus applicable to the Evaporation of Sewage or other Waters, and for affording Heat for other purposes.*

THE very great advantages of this invention, in its several applications, depend mainly on two principles, the former of which was partially known previously to the time when (November, 1857) they were both accidentally discovered by the Inventor. The first is, that steam at a certain temperature will, in contact with ignited wood, coal, or coke, decompose and burn; the second, that whatever amount of steam a given fire will generate, any portion of that steam, or the whole of it, may be passed into and through that same fire with increase of heat and saving of fuel. The Inventor has passed half-a-gallon of water per minute through the furnace which evaporated it, with the expenditure of only 2 cwt. of gas coke in twenty-four hours.

The Stove (Fig. 1) may be either cylindrical or oblong. It consists of a furnace, A, with an ash-pit and steam chamber, B, beneath, and a boiler, C, either annular or tubular, above it. The water is supplied to the boiler at the lower part of it by a pipe, D, connected with a self-supplying cistern, and furnished with a cock, E. Another pipe, F, G, conveys by its lower branch, F, any portion or the whole of the steam into the chamber, B, beneath the furnace, and so into the furnace, and by its upper branch, G, it conveys what portion may be required into a vessel or chamber, which may be connected with the stove for the purpose either of cooking or drying. The smoke and any steam which may escape may be conveyed by the flue, H, into a chamber or flue round an oven, before it enters the chimney. The stove is also furnished with an index-glass, I, and a safety-valve, K.

Fig. 1.



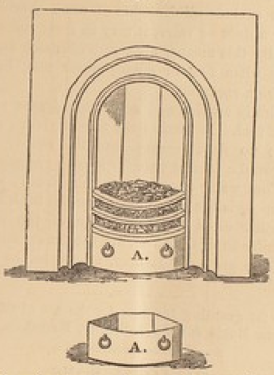
ELEVATION.
Scale ⅜-inch to 1 foot.

Through the last winter, one of these, only 3 ft. in height and 11 in. in diameter, was sufficient to warm a schoolroom 52 ft. by 29 ft., and 18 ft. in height, with less than 14 lbs. of

gas coke for eight hours. The Schoolmaster steamed his dinner by it, and occasionally steam was let off with great advantage for the freshening of the air.

Careful experiments have given the following results. If no steam were passed through the fire, the evaporation was 5 quarts an hour, with the consumption of 5 lbs. of gas coke. When all the steam generated was passed through, the evaporation was 8 quarts in the same time with consumption of only 4 lbs. of coke.

Fig. 2.



With 28 lbs. of coke for fourteen hours, this same stove has warmed the same room, during thirteen hours of which time a portion of the steam was used for cooking, and during twelve hours an oven was kept at a temperature of 240°. The oven might be placed on one side of the stove, and the steaming apparatus on the other, and a hot-plate be formed by the top of the stove and the connecting flues.* The stoves

* Ranges on this principle are now manufactured by Taylor and Sons, High East Street, Dorchester.

as here figured would be admirably adapted to Waiting Rooms at Railway Stations, and to entrances and passages in large Hotels. If used for steaming food for cattle, it would save at least 75 per cent. on the ordinary mode.

The invention, as applied to a Grate (Fig. 2), whether for Parlour, Kitchen, or Cottage, or to Kitchen Ranges, or to Furnaces, consists of an iron water-tight drawer, A, fitted so closely beneath the fire as that the water poured into it may have the fullest advantage of both radiation and conduction of heat from the fire for raising the steam, and so as to exclude all draughts of atmospheric air except such as, by a door or valve, it may in some cases be wished to admit. By this means, also, any offensive smells, which might arise when foul or greasy water may be used, are prevented from escaping.

When rightly applied and used, this drawer saves full 50 per cent. of fuel. It renders the fire brighter; greater heat is emitted; no dust escapes into the room; and it has hitherto proved a perfect cure for a smoky chimney.

N.B.—Foul water burns better than fresh; and the best for the purpose is the dish-water from the back kitchen.

In all other cases the application of the invention is exactly similar to this (Fig. 2), but the drawer not necessarily resting on the ground. It may, of course, be made more ornamental.

Agents for granting Licences for the use of this Patent, Messrs. Moule & Gore, Solicitors, Melksham, Wilts.

TAYLOR & SONS,
HIGH EAST STREET, DORCHESTER,
LICENSED MANUFACTURERS OF THE PATENT VAPOUR-FED STOVE, GRATE, AND KITCHEN AND COTTAGE RANGES.

T. WELLMAN,
CARPENTER,
HIGH STREET, FORDINGTON, DORSET,
LICENSED MANUFACTURER OF THE PATENT EARTH CLOSETS, EITHER FIXED OR PORTABLE.

My dear Sir Gravesend
21. Feb 63

If you have not already perused this Pamphlet - I feel assured that your desire for the health & comfort of the Troops under your Command will induce you to read it and carry into effect the plans therein stated - which may be easily effected, now that the Builders are at your disposal - hoping you will excuse this liberty

I am My dear Sir Yours truly H W

Dr. Parkes
with Mr Menzies' Complts

ADDITIONAL STATEMENTS

BY

MR. WILLIAM MENZIES

IN SUPPORT OF

HIS PLANS FOR THE DRAINAGE OF TOWNS

AND IN ANSWER TO
THE OBJECTIONS WHICH HAVE BEEN RAISED TO THE SYSTEM
HE HAS PROPOSED.

LONDON:
LONGMAN, GREEN, LONGMAN, ROBERTS, & GREEN.
1865.

LONDON
PRINTED BY SPOTTISWOODE AND CO.
NEW-STREET SQUARE

THE

DRAINAGE OF TOWNS.

It is very desirable that we should lay down the essential points of the question at the elucidation of which we must aim to arrive. The whole subject is not one to be settled separately on either medical, chemical, engineering, or agricultural considerations; and it would be very unsafe to follow the guidance of any person who, looking at the matter in one of these aspects alone, paid little or no attention to the others.

It is of much importance that all these different subdivisions should be discussed by those specially conversant with each branch; but it is only by combining the whole, and taking the balance of advantages and disadvantages, that we can arrive at conclusions that will satisfy the whole country as to the propriety of the course which should finally be adopted.

The principles to be laid down are:—

1*st.* That the whole scheme, both in the towns and in the country, shall be the most sanitary one, and shall be no nuisance, or the least possible nuisance, to any one.

2*nd.* That the scheme must be *perfect* and economical, not only to design and carry out in the towns, but also in all the processes connected with distribution and utilisation of the sewage in the fields until some really practical profit is derived from the application of the liquid to the land.

3*rd.* That no sewage impurities whatever shall pass into the rivers, neither in winter nor summer, rain nor sunshine, night nor day, and that nothing valuable as manure shall be lost.

4*th.* That the whole shall be practicable in every case.

In addition to the arguments stated in my book on the subject, in support of the plans I have laid down, I shall now attempt to strengthen them by further statements, and to meet the objections that have been raised in various quarters.

1*st.* That the whole scheme, both in the towns and in the country, shall be the most sanitary one, and shall be no nuisance, or the least possible nuisance, to any one.

I have given very strong evidence in my book* to show that a vast amount of fœcal matter remains

* The Sanitary Management and Utilisation of Sewage. By Wm. Menzies. Longman & Co.

putrefying in the drains of towns as they are at present formed, in consequence of the prevalent system of trusting so much to the rain water for flushing purposes, and that thus foul air of the worst kind is discharged either through the street gratings, which let down the surface water, or into the houses, and that malignant disease is the result; and I have given statistics from the mortality bills to prove that such is the case. Against my statement it has been urged that, in a town thoroughly well drained according to the present plans, the whole or the greater part of the fœcal matter is discharged every day at the main outlet. If this is so—although I greatly doubt it, and should like to see it supported by a chemical analysis—it is essential that the *whole*, and not a part, of the solid matter of the sewage should be so discharged, and that the system should work perfectly in long-continued dry weather. If these arrangements, then, are perfect for dry weather, what necessity is there for urging, as is always done, that the rain water is required as an additional help in wet weather? Again, if the arrangements do not act thoroughly in dry weather, all must admit that they are far from perfect, and fail in their most essential requirement.

Further, for the sake of argument, supposing that I admit that the flushing arrangements of any towns drained on the present system are so perfect that there was a constant stream of fresh sewage in the drains, would any person, if he could avoid it, have these open street-gratings and all the rain-water pipes about his house communicating with the sewage, if, by a better arrangement, he could be rid of or lessen the nuisance and danger?

In fact, if any engineer were to set himself the task of devising the best means of discharging, in the midst of the population, all the stench possible from sewage drains in a town, it would be difficult for him to plan a more complete method than these gratings afford. They act as feeding-shafts to a furnace. When the streets are hotter than the interior of the houses, which they are in summer, then the foul air comes up in some special warm corner or alley, and the draught is fed from some grating in a cooler place. If the houses are hotter than the streets, which is the case in autumn, spring, and winter, then the gas is sucked into them, and the street-gratings keep up a constant current. Against such a system all ordinary traps in the houses will fail, and every imperfection in the pipes inside the house gives an opening to the gas. There must, therefore, be always a draught either up or down these gratings, and in both cases the current has an inlet for a fresh supply of air, to be again contaminated and again discharged.

If the fœcal matter accumulates in the drains, there is no question as to the deleterious effect on the inhabitants of an escape of such foul air; but, even on the supposition that the sewage is quite

fresh, and that the effluvia from that comes up into the streets, Dr. Parkes, in his recently-published work on 'Practical Hygiene,' with far greater knowledge than I have on this point, when speaking of sewage in any condition as a source of disease, says:—

> To sum up, the diseases produced by fœcal emanations on the general population seem to be—diarrhœa, bilious disorders, often with febrile symptoms; dyspepsia, general malaise, and anæmia; all these being affections of digestion or sanguification. Typhoid fever is also intimately connected with sewage emanations, either being their direct result, or more probably, being caused by specific products mixed with the sewage.

Dr. Parkes, in his admirable work, after giving statements and statistics which cannot be disputed, carries this principle so far that he recommends, in order to avoid the danger of effluvium in any shape, that the whole evacuations and vomitings of patients suffering from fever, cholera, dysentery, or diarrhœa, should be at once conveyed away by themselves and buried in the earth. This principle has been reckoned so important that a special general order has been passed, directing it to be invariably followed by the medical officers attached to the army in India. Such a process could not be accomplished in towns; but can there be any doubt that the gas liberated from either fresh or foul sewage should be prevented, on sanitary grounds, from being discharged anywhere except either freely over the tops of houses or into furnaces; and that the arrangements made at present for retaining gratings or other openings into the foul drains for the purpose of receiving the rain water, are highly objectionable?

The system which I have advised of filtering the sewage is also sanitary, because the whole is confined in a sealed chamber from which no effluvia can escape except through an air-filter of charcoal, which renders innocuous any injurious gas. Again, the water that flows away, after filtration, for irrigation purposes is in a perfectly fluid state, so that, on arriving at the land, it is speedily absorbed; while, if it contained all the solid matter in suspension, that is not only disagreeable to the sight, but so far more dangerous, as it lies longer on the surface before it is decomposed and incorporated with the earth. Irrigation without filtration would not be tolerated near any asylum or hospital.

It is also highly desirable, in a sanitary light, that no water whatever tainted with sewage should, if possible, under any circumstances of season or weather, or even with any amount of dilution, flow into the streams of the country without having first passed, *not over* the surface of the earth, as many people think is sufficient, but *through* the earth, at least four or five feet in depth. Every medical man will bear me out in this, and that it is advisable so as to lessen the danger of both originating and spreading disease, especially when sewage is discharged into rivers in the interior of the country.

Let me take, in support of the views expressed in my book, another additional case now attracting

attention. It is known that the eggs of human parasites are conveyed in countless multitudes into the sewage, and then, when embodied in water, pass into some transition state, in which they are again conveyed into the human frame through drinking water. If these eggs are delivered on to dry land covered with a crop, and made to pass through the soil, the eggs generally lose their vitality, and the risk of propagation is reduced to the minimum.

As long as the rain and storm water all go with the sewage, the advocates of that system admit that when pumping is necessary for irrigation purposes, which it will be in so large a proportion of cases, a great part of the storm sewage, which, whether it is fresh or putrid, may contain millions of these eggs, must pass into the streams of the country, to the additional risk of spreading disease.

River waters are, generally speaking, the best for domestic purposes on a large scale, and will continue to be much used; while, again, the human frame possesses some far more delicate power of showing impurities than any chemical or microscopic analysis can supply. I shall attempt to prove under the next division of my subject that if, to avoid that danger, provision is made to collect and pump up all the rain water with the sewage, economically the system must fail and be ruinously expensive.

2nd. That the scheme must be *perfect* and economical; not only to design and carry out in the towns, but also in all the processes connected with distribution and utilisation of the sewage in the fields, until some really practical profit is derived from the application of the liquid to the land.

I may state another argument, on mechanical principles, showing how inefficient and imperfect rain water in its action must necessarily be as a flushing power.

Water, when confined in cisterns and suddenly liberated, has a great tendency to act by pulsations, or waves. When these pulsations increase in force they become *concussions*, and, as every one knows, 'concussion' produces a very different effect from gradual or steady pressure. Keeping this principle in view, we see that rain water, in addition to its having a larger pipe to act in, when it goes with the sewage, and so loses its force, can only, during the time it falls, act by a steady gradual pressure, and not by 'concussion.' When rain begins to fall, the ground absorbs a considerable quantity of it; then it begins gently to trickle into the drains from a vast number of places; increases gradually; remains constant in volume for a time, and then gradually dies away again. Carrying with it, as it always does, the mud off the streets as a dead-weight, and increasing its friction on the sides of the large drains, it never exercises the power of concussion, and would not have the same effect as the tenth part of the water if allowed to go, as it ought, with a rush from a proper flushing cistern into a smaller drain.

Then, agriculturally considered, when the rain water goes with the sewage, and is applied to land, the system is most imperfect and uncertain. Besides what I have said in my book, I would merely add, that water in itself is not a source of fertility to land. It is an excellent agent for carrying or developing sources of fertility, but in itself it has little or none. In fact, an excess of water is ruinous and exhaustive, and any meadows irrigated with pure water would soon become worthless. The water must, if the fertility of the soil is to be kept up, contain a certain amount of ammonia or other substance on which plants can feed, and the question at issue is, 'What is that amount per gallon?' Profitable agriculture is not regulated by questions of the chemical value of manure alone, but is a more comprehensive study of the state in which that manure is, the cost of applying it, and the mechanical condition of the land, as to wetness and dryness, upon which that manure is applied. The common sense of every man will guide him in forming the opinion that, if you dilute all the daily excreta of a human being in more than 25 gallons of water, or six times what would fill an ordinary stable pail, the extreme limit of dilution is reached that land generally could bear to advantage. In summer and in dry weather all will go well with that amount of dilution; but in winter and wet weather, when vegetation is dormant or the earth is saturated at any rate, then it is an immense advantage to reduce the sewage water to the minimum; or, if I am not correct, all the principles upon which we have been acting for years, of thorough underground drainage, are wrong. For it must and ought always to be borne in mind, that the land must and ought to take the sewage in winter as well as summer, and that all parts of the kingdom are not like Devonshire, where they scarcely ever have frost. It has been stated in many quarters that the soil in this country is gradually becoming exhausted; but no one will believe it in the face of the oldest cultivated lands near the Abbeys being still the best; while every one knows that the yield of farms per acre keeps gradually increasing. The causes are various and numerous, and I need not at present enter into them. In reality, the only lands which are less fertile now than they were thirty years ago are meadows which have been irrigated profusely with water too poor in itself to keep up the supply of nutriment to the vegetation which the liquid excited into an unhealthy action. This ought to be an especial warning against the dilution of sewage beyond a fixed point. Again, where manuring is done by farmers in winter, as is the case upon young clover, or as a preparation for a root crop, the work is done more to save damaging the land by the necessary carting, and to keep the land mechanically open, than that it is the best season for such an operation. No person would ever think of

putting on any manure, solid or artificial, and washing it in with water in the winter time. Therefore, when we receive chemical anaylses of sewage, we must consider the circumstances under which it must be applied. There is not, and ought not to be, any choice in the matter, but the land must receive it at all seasons. Neither is it sufficient to say that the sewage in winter upon land does not do much harm. The question is, 'How is the harm to be reduced to a minimum?' It is perfectly certain that excessively diluted sewage will upon most soils do great harm if the soil is compelled at all seasons to receive it.

Again, it has been stated in some reports presented to the Metropolitan Board that sewage as manure would be most beneficially applied to 'arable land.' I presume that by that 'cereal crops' is intended.

These crops are wheat, barley, oats, and beans. Sewage is *liquid* manure, and during winter and early spring every agriculturist knows that a dry seed-bed is of the first importance, and no farmer would put sewage on during that time. Directly, again, that the crops get above one foot high, or when they are ripening, irrigation would both be impossible and imprudent; so that during the whole year we should only have about one month, at the outside, in which irrigation was to take place; and what was to become of the liquid all the remainder of the time?

Also, how would it be possible to manage the irrigation except by iron pipes and hose, which we all know to be too expensive?

While, further, in the ordinary cultivation of farms, a cereal crop that is too heavy, and so runs the risk of being all lodged and damaged by July rains, is almost as much dreaded by the owner as one too light.

The same arguments will apply, to a certain extent, to the alternating crops of potatoes, turnips, cabbages, or mangold wurzel. The liquid could only be applied to them for a few months during the early stages of their growth.

All the discrepancies that have come before the public as to the amount of sewage water that might beneficially be applied to an acre of land, have arisen from the evidence collected from places acting under different circumstances, and are more or less connected with the rain-fall, going as it does into the same drains as the sewage.

In some places that have been quoted they have 20 inches of rain-fall in the year; in some 30 inches; in some they have taken the sewage when they wanted to do so, and sent it into the sea when they did not; in some cases the towns are full of water-closets, in others there are cesspools remaining; in some cases the dry-weather sewage has been pumped through the day over a limited area, and the overflow allowed to go into the streams; in some cases the land has been so porous that any quantity of water would pass down naturally

through it, leaving the fertilising qualities it has in suspension behind; while in others the land irrigated has been clay, and level, and those in charge had to see that no damage was done by too much flooding of the land; in some cases pumping did all the work; in others gravitation entailed no working expenses; and in scarcely any have the experimenters been compelled, as I believe all will be eventually, to utilise the sewage in all weathers and in all seasons.

In some cases the streets of the town have been covered with trap-stone; in others with rocks full of quartz or silex; very different articles when decomposed and washed down upon the land.

As there has been in no case a fixed amount of dilution, with a daily delivery on to the land in all weathers, no satisfactory data could be obtained as an uniform guide, but much might be done to put the public right if careful statistics of each, such as they are, were obtained, and the principles applicable to the whole were brought out, so that some sounder basis might be laid down, and a mania for sewage speculation might be obviated.

It seems very suspicious, as has been well pointed out by Mr. Rawlinson, that the Town Council of Leith, with the case of the large rents obtained from the Edinburgh Meadows immediately adjoining, should be spending 60,000*l.* in sending the sewage of the town into the sea.

Then, again, the pumping of the sewage when mixed with road grit is not economical, because the sand increases the friction on the pipes, and thus more force is necessary. For the same reason filtration of sewage is economical, as the liquid is then easier pumped than when the solid matter is with it. It might here be objected that the separation of the solid matter from the fluid, which is accomplished by the filters I have advised, will much weaken the strength of the liquid for irrigation. This is more imaginary than real, because the stream of water constantly passing through it dissolves and carries away in solution the greater part of the solids, and but very little is left.

Further, the whole process must not only be economical in the original construction of the drainage in the towns, but must be so in the utilisation in the fields, and that both in the first outlay and subsequent maintenance. For, in reality, the right principle would seem to be that the corporations of towns should carry out the process from first to last, and that the planning of the utilisation should be in the first instance considered quite as essential as the drainage of the towns.*

To return, however, to the economical view of the question in its widest sense.

I cannot take for illustration a better case than that of London.

* See the case of Spokes *v.* The Banbury Local Board of Health, quoted in the *Times* of March 2, where Vice-Chancellor Wood has passed an Injunction compelling the Board to desist from polluting a stream.

I am not prepared to maintain that it would be always cheaper, or as cheap, to construct two sets of drains in a town as to lay down one; but I believe that part of the subject to be open to much consideration. Most of the towns in the country are built either parallel to the course of some river, or to the sea-shore.

The streets generally run perpendicular to that line, and the rain-fall drains might discharge at the end of each street, and great part of the water might in floods run along the streets themselves, so that these drains would not require to be very large, as they would have so many outlets. Again, the sewage drains would run parallel to the course of the river, passing under the others, and be taken away to some point to be utilised.

As much smaller drains then would be used for both, I think it is a matter open to full investigation whether the two sets would not be as cheap as the one, and from their smallness present less difficulty in their original formation. My own experience for large buildings is, that when planned from the first on the double method, that system is in many cases—if not the cheaper—quite as cheap as the other. But be that as it may, we must follow up the process on to the utilisation, and especially where pumping is necessary, which in by far the greater proportion of towns it will be, and then the economical bearings of the two systems under discussion begin to come out. With reference again to London, it seems imperative that the sewage should not be discharged at Barking Creek, and that something must be done. In my book, page 70, I give my reasons for thinking that a huge deposit of filthy putrid mud would form at the outlet of the main sewers. Since that was written, strong corroborative evidence has appeared in Dr. Letheby's report, published in *The Times* of 25th January 1865. He says, 'In consequence of that absence of wet in 1864, the river was charged during the summer and autumn with a large proportion of saline matter. As early as the end of May it contained as much as 124 grains of saline matter per gallon, the average proportion in a normal state of the river being but 24 grains, and by the end of August the quantity of impurity had risen to 386 grains per gallon. Nearly the whole of that was saline matter from the ocean, the flow of the stream having been upwards instead of downwards; but with that saline matter there was also brought up a large proportion of sewage, the quantity of organic matter (chiefly of sewage) being 43 grains per gallon. It was fortunate that the weather was unusually cold during the whole of that time, and therefore the river did not become offensive from putrefactive decomposition; but if the temperature had risen to 68 or 69 degrees, as it did in the summers of 1858 and 1859, the effects of it would no doubt have been seriously unpleasant. That which kept down the offensiveness of the river during the

summer time was either a low temperature or a copious rainfall; and it was manifest, from the experience which had been gained from the regular examination of the water of the river during the last six years, that there were periods of many months' duration in every year when, from the evaporation of the water and the small supply from above, the flow of the stream was not downwards but upwards, and that at such times the sewage discharged into the river, even so low down as the present outfalls, would flow upwards to a distance far above the city bridges. If at those times the temperature of the water rose above 66 degrees Fahrenheit, and the rain-fall was less than usual, the river would undoubtedly become offensive unless some means were taken for the defecation of the sewage before it was discharged into the river at the new outfalls. He had brought that under their notice on several occasions, because he believed it to be of very great public importance.'

The effect will therefore in all probability be, that even if the sewage is discharged at high water at Barking Creek, as the current has been proved to be upwards in the summer, the sand and gravel will fall first to the bottom and settle there when discharged, and the solid matter of the sewage will float on the top. As also the bottom water of all rivers and streams travels slower than the top water, the solid parts of the sewage mixed up with salt water, and stinking then worse than ever, will, to a certainty, come back to the heart of London and above the bridges, while the mud, which I believe often acted as a deodoriser, will be left further down the river. This must, therefore, be remedied in some way.

If the City of London,—and the same argument will apply to all other towns, is determined to pump all this stuff at whatever cost, and send it further into the sea or on to the surface of land, and carry out the whole process as a sanitary measure, then the public can understand it; but when companies come into the market, promising great returns from the outlay, and asking for Parliamentary powers to pass through lands and to borrow large sums of money, we may well examine the probabilities of their anticipations being realised, and so save disappointment and loss to those who invest their money in the scheme; while, besides, a true solution of this difficulty will be thrown back for many more years.

In an anonymous pamphlet lately published, entitled 'The Agricultural Value of the Sewage of London,' &c., there is a statement of the works proposed to be done by Messrs. Napier and Hope, in order to carry out their scheme for utilising the sewage of the metropolis. From this we learn that the liquid will be sent through a culvert, 10 feet in diameter at first, then passed into two branches, fully 40 miles in length, with *two* stations on the line at which the whole must be pumped up; at the first, 20 feet; at the second, 12 feet. The cost is

estimated at something over two millions. To this, however, should be added the expense to which the farmers along the line must be put in preparing their land to receive the liquid; and this, it will be found, will be no small item.

Some statistics of the probable revenue are then given, and the question is asked, 'What better investment can be desired?'

It is unfortunate, however, for the great anticipations held out, that in the Appendix marked A, opposite page 70 of the same pamphlet, very different results from the application of sewage, diluted as all sewage is by the present system of town drainage, appear to have arisen when pumping, not even at *two* stations, but at *one* have been necessary.

The first case quoted in that Appendix is,—

> Alnwick, 6,400 people. Use discontinued. Farmers refused to pay the cost of pumping.

Another is—

> Rugby, 8,000 people. £50 a year paid to town.
> Watford, 4,000 people. £10 a year paid to town.
> Worthing, 7,000 people. Not yet at work. No rent. [Here I know that the pumping is done for the experimenters.]

The population of London per square mile is in the densest locality said to be about 175,000, and from this it gradually diminishes to a much smaller number in the suburbs. As the metropolitan drainage area however is, roughly speaking, 100 square miles, and the total population three millions, we have a general average of 30,000 per square mile. The water supply sent from the companies being about 25 gallons a-day per head, the daily discharge from the inhabitants of each square mile will be 750,000 gallons. This will all arrive with slight modifications every day at the mouth of the main sewers, and must all be pumped for irrigation at great cost.

In June and July, however, we have frequently $1\frac{1}{2}$ inches of rain-fall in the same period of 24 hours, and in the winter also often 1 inch in the same time. It would be a liberal allowance for evaporation and absorption in the summer to deduct one-half, and in the winter one-quarter of that rain-fall. We should thus therefore have 3-4ths of an inch of rain-fall over the square mile coming down with the sewage, which ought to be pumped up as well. 3-4ths of an inch of rain-fall over a square mile gives 10 millions of gallons, which would have to be provided against as well as the regular supply of 750,000.

This would require for these extreme cases, which however happen every year, a sort of reserve power about twelve times that necessary for ordinary use. The storm overflows will, no doubt, take off great part of this, mixed with putrid sewage, and send it direct into the river, and the greatest and filthiest gluts will happen in the summer; but Mr. Bazalgette states in his evidence before Lord Robert Montagu's Committee, question 5,186, that he provided to meet

even the ordinary heavy rains four times the pumping power necessary at other times; and Sir C. Fox, at question 1,380, to meet the same contingency, proposed to provide rather more. Then again all the delivering channels away into the interior of the country must be on the same larger proportion; the land irrigated ought to be four times the extent it need be, and the water delivered will only contain one-fourth part of the usual fertilising value. What an enormous amount of invested and unprofitable capital must these extremes involve! What heavy working expenses so as to be provided against all emergencies! And is it not almost certain, on ordinary engineering and mechanical principles, that such excessive power and arrangements will not do the dry-weather sewage work, which is the really paying part of the process, so efficiently as pumping apparatus designed expressly for smaller and fixed quantities? As such an enormous sum of money must be invested to provide for these rain-fall contingencies, which agriculturally will only do harm, it would seem to me to be worthy of all serious attention, whether it would not be more prudent to revise what has been done and spend some of the money in changing, what I believe to be, a wrong system of drainage, and so bring the whole into a manageable state for those who deal with the sewage after it is discharged from the main drains, and have to utilise it in the fields. It is quite possible that it may now be the best course to adopt to allow all the drains to remain as they are, and pump the whole diluted and uncertain mass away for irrigation and make the most of it; but it is open to very full investigation whether it would not be cheaper and more advisable to cut off in the streets as much of the rain water as possible, and so bring the whole under control.

Such a statement could only be framed in the following way:—Presuming that a fixed dilution of 25 gallons per head could be arrived at, as we know is desirable agriculturally, a calculation of the cost would have to be made of building filtering tanks at the mouth of the main drains; and to this must be added the prime cost of erecting the necessary pumping apparatus, and the capitalised probable annual working expenses of these pumps. Then further add to these the expenses of constructing the main irrigating channels on this reduced scale, and also the probable cost per acre of laying the liquid on to the land, the preparation of the land and the annual expenses of working it, and there must be credited to the process the probable returns, which will be greater. On the other side, sum up the cost of pumping the rain-fall along with the sewage as at present, and the first outlay and annual expenses of all future works necessary to meet that increased quantity—all the expenses both of prime cost and maintenance of so much larger a system of distribution, the additional cost of irrigation, and consider the smaller sums that will be obtained for the use of such a dilute mass. The difference

between these two total sums would show how much might yet be spent beneficially in cutting off the rain water and sending it by every possible means direct into the Thames.

It seems to me most desirable, for the guidance of the community in future, that such an enquiry should be made, so that the precedent of the metropolis, if that should be proved not to be the best, might not be established.

If in towns again, for the sake of economy, pumping power is only provided to raise up the dry-weather sewage, a well must be built somewhere in the line of the main drain, and the pumps set to work. I may assume the number of heavy rain-fall days during the year at 50; irregular and uncertain as they are.

Directly the rain comes down, bringing along with it the sewage into this small well or tank, of course on these 50 days the whole quantity is in excess of the power of the pumps. The solid matter of the sewage will immediately then float to the top of the well, and must pass away by an overflow into some stream, while the pumps sucking, at the bottom of the well, will be busily engaged in raising little else than rain water and the road grit, and sending it upon the surface of the land, which will besides, during all that time, be receiving naturally its full share of rain water. Further, the stream or ditch into which the solid matter will be discharging from the overflow, will become more stagnant directly the pumps recover the mastery of the supply from the drainage, and, I rather think, will be in a worse state then than if all the liquid were allowed to go along with it and keep the whole moving on.

I think I need scarcely enter into the question of economical utilisation in the fields, as every one can see that to have provision made for irrigating with such excesses of rain-fall must be out of all reason, and that 25 gallons per head of the population is quite enough to provide for. The real principles to be acted on I believe are, after having fixed quantities of sewage—which I should like to see reduced to 10 or 15 gallons per head—then to put as much water in summer upon a limited area of as porous land as possible, so as to lessen the cost of supervision and distribution; and again in winter to spread the water out widely, so as to lessen the chance of over-saturation of the land.

Again, in the case of towns situated within the influence of tidal rivers, the carrying of the sewage and rain-fall together entails expensive arrangements, when the whole is to be pumped into the stream; because the sewage cannot be delivered when the tide is rising, for fear of bringing it back to the town; but the whole must be retained, both rain-fall and sewage, for many hours, until the tide has turned. To meet this requirement for London, Mr. Bazalgette states in his evidence (questions 5,130, 5,140) that tanks had to be made nearly 15 acres in extent and 14 feet deep; an expense that might, under the plans I am advocating, have been

immensely diminished. Filtering tanks and a small outside receiving reservoir for the sewage during a few hours at night, when the discharging water is reduced to the minimum, would have been sufficient; because a fixed engine could then have gone on pumping the liquid away into the interior for irrigation, quite independent of the tides and rain-fall.

3rd. That no sewage impurities whatever shall pass into the rivers, neither in winter nor summer, rain nor sunshine, night nor day, and that nothing valuable as manure shall be lost.

This is surely the great point to be arrived at, and the only one that will be and ought to be really satisfactory to the whole country. All those who have given their evidence as yet before the different Committees of the House of Commons and elsewhere, have constantly said they could not by any of the present schemes for utilisation accomplish this; while, at the same time, recommendations are everywhere put forward that all towns should be compelled to desist from polluting the streams, and lamentable accounts are given, which are only too true, of the state of the rivers in some parts of the kingdom. I have kept this constantly in view, and never could see any other way of accomplishing what was wanted, except by the means that I have ventured to lay before the public.

We must however first, as I have pointed out in my book, have a general Arterial Drainage Bill, so that the flooded valleys, which are so common by the side of rivers, may be drained and prepared for irrigation.

The laws of the country are not at present sufficient to prevent the pollution of rivers, because these rivers are not the property of any single individual, and a Bill compelling the utilisation of sewage would probably be the proper measure to pass some years hence; but at present it would be premature, because a perfect remedy has not yet been carried out on such a scale as to satisfy the whole country of the reasonableness, the necessity, and the practicability of such a measure.

If conservators of rivers are appointed, it should be their duty to see, not that sewage from towns is utilised in dry weather, and that in floods, or storms, or in winter, or at other times it comes into the streams, but that it shall not enter them *under any circumstances*, or with any amount of dilution, without having first passed through the great natural deodoriser, the earth; and I believe no system will be ultimately accepted by the general public except this is accomplished. If any other result than this is obtained, an immense expense will be incurred; the evil will only be half cured, and all will have to be done over again at some future time.

4th. That the schemes shall be practicable in all cases.

Under this head I am ready to admit that the most serious discussion will arise.

I was not aware until about a month ago that the separation of the rain-fall from the sewage had ever been advocated in any substantial form, the greater part of the suggestions in my book having been the result of my own observation and experiments.

All credit, however, is due to those who perceived years ago that in all probability in that direction lay the solution of the sewage question. It has also been urged that some 15 or 20 years ago, plans, something similar to mine, were proposed and proved to be failures or rejected. I have not thought it necessary to go back and consider all that was said either on the one side or the other at that period, and think that it is far more reasonable to discuss the matter with the knowledge we now have, and the experience we have gained since then, through the vast amount of labour, attention, and study, that have been given to the subject by Mr. Lawes, Mr. Rawlinson, Mr. Morton, and others. It is notorious that about 20 years ago the first consideration with every engineer was how to get the filth out of the towns by the speediest and simplest manner possible, and that the pollution of the rivers and the attendant evils were little thought of, or put aside as of secondary importance; while the agricultural aspect of the question had not been studied, and no one thoroughly conversant with its practical requirements had shown the principles upon which utilisation in the fields must be accomplished.

Can any one further say that the plans which were adopted after the discussions of that day have been so eminently successful as to preclude any one now re-opening the question, and considering whether some better scheme than the present one may not be found out? It would put an end to all progress if we were to rest satisfied with arrangements and proposals thought to be the best 20 years ago.

Then, as to the fact of my plans being now practicable, I think I should be paying the engineers of the present day a very small compliment if I said that they could not plan one set of drains to pass over the other, or alongside, or even inside one another in any town whatever. The difficulties, no doubt, increase with the area, but in a much greater degree so do those of the present system. I have very little fear of the double system being accomplished, if those who make the attempt see at the commencement that there is no other way of succeeding, except by separating the rain-fall from the sewage.

I give my opinion with every deference and respect to those who have made a special study of the subject of town drainage for many years, and can only state as the basis of my opinion, that in the case of large public buildings, with their attendant dwelling-houses and cottages, I have seen no greater trouble in planning a double system than there would have been with a single one.

Again, the main sewer from a town of six or eight thousand people flows through property under my charge, and is itself in my care; and after making

many experiments and calculations as to the cost of pumping and distributing the liquid, I have declined to recommend an attempt being made at utilisation, on either sanitary or economical grounds. If any substantial company will come and plan, and be responsible for the whole utilisation, I should not only advise that the right to do so should be given them, but that a sum be added to help them. The company would find, as I have done, that it would be ruinous to provide, for the wet-weather sewage, such expensive lifting power and other arrangements as were necessary, and that when the greatest expense was being incurred, the farmers would be unwilling to receive the sewage at all, much less to pay for it. I should only make one stipulation with such a company, viz., that from the time of their commencement no impurities should afterwards overflow from their pumping station.*

If the last point I have mentioned become a fixed stipulation with all engineers at the starting, then I should have great hopes of their attempting the separation of the rain-fall and sewage.

Rain water can go down and up again, or syphon over, or run on the surface in many cases, so that there is little difficulty in dealing with it. Then again, where rain-fall drains had to cross those for

* The conclusions arrived at in my book and in this pamphlet are the result of my continued attempts to remedy the evils of that main sewer, which, although they might be mitigated by some of the plans at present before the public, could not be cured, and will no doubt remain as they are until a better system is devised.

sewage, a small well should be made on the upper side, and the sand off the streets would settle in that, and the overflow would pass underneath the sewage pipe.

Besides, where does the line lie between a large public building, and all its attendant houses and cottages, and a small country town or village; and where the line, again, between these and a large town anywhere else? The principle will surely hold the same in all cases.

Also, as there are storm overflows in most of the towns already, has not the double system of drains been so far recognised?

It is only by carrying this principle on to its natural conclusion that, I believe, we arrive at a true solution of the difficulties.

That there may not be points of objection which can be raised to my plans I am not sanguine enough to suppose; but those who point them out are bound to find another course with so few difficulties, and to show that by any of the present schemes so many of the essential points as I have laid down can be accomplished, in the drainage of the towns, in the purification of the rivers, and in the economical and perfect utilisation of the sewage in the fields.

LONDON
PRINTED BY SPOTTISWOODE AND CO.
NEW-STREET SQUARE

THE SUCCESSFUL APPLICATION

OF

CHARCOAL AIR-FILTERS

TO

THE VENTILATION AND DISINFECTION OF SEWERS.

A Letter

TO THE RIGHT HONOURABLE THE LORD MAYOR,
WILLIAM CUBITT, M.P.

BY
JOHN STENHOUSE, LL.D., F.R.S.,
LATE LECTURER ON CHEMISTRY AT ST. BARTHOLOMEW'S HOSPITAL.

LONDON:
JOHN CHURCHILL, 11, NEW BURLINGTON STREET,
MDCCCLXI.

LONDON:
REED AND PARDON, PRINTERS,
PATERNOSTER ROW.

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VENTILATION AND DISINFECTION OF SEWERS.

MY LORD MAYOR,

The high position you have attained by your professional ability as a Builder, together with the circumstance that you are the chief magistrate of the largest city in Europe, have induced me to address to you a few observations on the very important subject of the ventilation and disinfection of the sewers. When we consider that the sewers of London, pervading as they do every part of the metropolis, extend to some 1,500 miles, and that almost every house is more or less intimately connected with them, it is plain that their influence, in a sanitary point of view, cannot readily be over-estimated.

A badly-constructed or ill-regulated sewer is truly the modern Pandora's box, which contains within it many of the most dangerous diseases, such as typhus fever, cholera, dysentery, scarlatina, diphtheria, &c., ever ready to break forth and assail the hapless inhabitants of the neighbourhood. Now this is no poetical figure merely, but, unfortunately, it is but too often the sad experience of the inhabitants of every large town where sanitary regulations have been neglected. The ventilation of the sewers is not a matter of choice, for if they are not furnished with artificial openings they will ventilate themselves, for the large quantities of deleterious gases, produced by the putrefactive fermentation of the organic matters in the sewers, will overcome very considerable resistance, and force their way into the adjoining streets and houses, oftentimes with the most fatal effects. These lamentable results are by no means confined to the poorest localities, but not unfrequently occur even in the finest districts of our largest towns. In this way, through the ignorance and carelessness of some architects, who have neglected the most ordinary sanitary precautions in regard to the drainage, the most splendid houses are not unfrequently the most unhealthy. Till within the last few years, the ventilators for the sewers were reduced to as small a number as possible, and always placed in the centres of the streets, on account of the disagreeable and dangerous effluvia which, especially in warm weather, these air-holes were too apt to emit. At present, however, these air-holes may be increased to any extent, and placed in any situation; for since the application of the charcoal air-filters to the ventilating shafts of the sewers, the effluvia and

deleterious gases are effectually arrested and destroyed, by being subjected to a species of low combustion, which resolves their carbon into carbonic acid, their hydrogen into water, and their nitrogen into ammonia.

The nature and origin of the charcoal air-filter is simply as follows. It has long been known that the various kinds of animal and vegetable charcoal, especially when dry, possess the power of absorbing effluvia, and the greater number of gases and vapours. The subject was first investigated by M. Löwitz, a German chemist, who, toward the close of the last century, showed that charcoal might be made to deodorize and disinfect most putrid substances. About seven years ago, it was discovered by Mr. John Turnbull, of Glasgow, that when the bodies of dead animals are covered over with a few inches of powdered charcoal, and exposed to the air, though the bodies rapidly decay, not the slightest disagreeable odour is evolved. This result I verified in 1853, by burying the bodies of a full-grown cat and two rats, in about two inches of charcoal powder, and keeping them in my laboratory. The bodies of the animals rapidly decayed, but not the slightest odour was perceptible, nor were any injurious consequences experienced by any of the eight or nine persons by whom the laboratory was daily frequented. Toward the close of 1853, my attention was first directed to the deodorizing and disinfecting properties of charcoal, and I was not long in discovering that the views which had been previously entertained regarding the action of charcoal were exceedingly erroneous; for instead of acting as an antiseptic, and thereby retarding the decay of putrefying substances with which it was in contact, as had been previously supposed, its action was the very reverse of this. Charcoal, therefore, from the considerable amount of condensed oxygen contained within its pores, amounting to between nine and ten volumes, not only absorbs, but rapidly oxidizes the effluvia and miasmata emitted by decaying substances, and resolves them into the simplest combinations they are capable of forming.

All porous substances, such as platinum black, pumice stone, &c., possess the power of condensing gases within their pores.

The porosity of charcoal is much greater than many persons are aware of. Liebig states, in his "Letters on Chemistry," that the pores in a cubic inch of beech-wood charcoal must, at the lowest computation, be equal to a surface of 100 square feet.

When reflecting on the wonderful power of charcoal as a deodorizer and disinfectant, as exhibited in the cases already described, where, as we have seen, a layer of charcoal not more than two inches in thickness is capable of absorbing all the miasmata from such an extensive source of corruption as the putrid body of a large animal, it struck me that a thin layer of charcoal powder interposed between wire gauze would be equally effective in preventing the noxious effects which too frequently result from the very minute quantity of putrid infectious matter

floating in the air of what are generally known as unhealthy situations.

These considerations led me to construct the so-called charcoal air-filter for the purification of the atmosphere, which was first publicly exhibited and described by me at the meeting of the Society of Arts, on the 22nd of February, 1854.

The charcoal air-filter consists of a layer of charcoal in coarse powder, varying in size according to circumstances, between a small bean and a filbert. The charcoal is placed between two sheets of wire gauze fixed in a frame, and can be readily applied to buildings, to ships, to the air-shafts of sewers, to water-closets, to respirators, and various other purposes. All the impurities in the air are absorbed by the charcoal, so that a current of pure air alone passes through the filter, and in this way pure air may be obtained from exceedingly impure sources. It is plain that perforated zinc, or a framework of coarse wire filled with larger pieces, and a greater thickness of charcoal, may be also employed, whenever the amount of effluvia evolved is very considerable.

Before the close of the year 1854, air-filters or charcoal ventilators were fitted up both at the Mansion House and Guildhall. They are each of them several feet in diameter, the layer of charcoal being about one-and-a-half inches in thickness. Although six years have elapsed, the charcoal has never required to be renewed, owing to its oxidating power being practically unlimited. Air-filters were soon afterwards largely employed in private houses, in connexion with drains and water-closets particularly, and they were also very successfully applied to the construction of respirators, many thousands of which have ever since been annually manufactured by Mr. W. B. Rooff, of 7, Willow Walk, Kentish Town. On the 2nd of March, 1855, I delivered a lecture at the Royal Institution, on the Economical Application of Charcoal to Sanitary Purposes. It was subsequently published by Churchill, and passed through three editions. In it, the preceding and many additional facts were made known to the public.

Some time after the publication of this lecture, Mr. Robert Rawlinson, the eminent engineer, was induced to apply the charcoal filter in the beginning of the year 1856 to the air-shafts of sewers. The charcoal filters are so arranged, that while the charcoal is kept dry the whole of the air issuing from the sewer is made to pass through the charcoal, by which all its impurities are retained and destroyed, nothing but pure air passing up into the street. From the extreme porosity of the charcoal it does not sensibly injure the draught of the air-shafts, and by increasing the size of the filter—for instance, by doubling its diameter, or what is perhaps much better, by adding to their number—any diminution of air-way may be easily prevented. These filters, from their simplicity, are by no means costly in their construction, and if kept dry, the charcoal never requires to be renewed.

Mr. Rawlinson has hitherto employed tolerably

thick single filters placed perpendicularly. I should prefer using two or more thin filters placed at short distances, say two inches, from each other. These thin filters disinfect the air quite as efficiently as a single thick one, and I think they present rather less obstruction to the air. There is this disadvantage also attending the use of the upright filters, that after a time the charcoal is apt to subside a little, and leave an opening at the top, through which a portion of the air may escape. This, however, is easily prevented by placing a bar of wood or metal, from two to three inches broad, right across the upper part of the outside of the filter. When this has been done, even should the charcoal subside for an inch or so at the top of the filter, no air will be able to pass through which has not been disinfected by the charcoal.

I purposely omit any engineering details of their construction, as I understand Mr. Rawlinson intends publishing a paper on the subject, in which these will be fully described. As will be seen by the subjoined letter, Mr. Rawlinson, during the last four years, has applied charcoal air-filters to the ventilation of sewers on a large scale, at West Ham, near London, at Swansea, Worksop, and Buxton, the entire towns; at Brighton partially; at Bowood, the seat of Lord Lansdowne, and at various other places.

In 1858 a very important and able report on the state of the sewers, and the various means which have been proposed for disinfecting them, was published by Dr. Letheby, Health Officer of the City of London, and Lecturer on Chemistry and Medical Jurisprudence in the Medical College of the London Hospital. After a minute and rigorous examination of the various methods proposed for disinfecting the sewers of London, some of which were enormously expensive, those with bleaching powder and permanganate of soda being estimated to cost from 200,000 to 270,000 pounds for a single year, Dr. Letheby strongly recommended the employment of charcoal air-filters, as infinitely the cheapest and most effective of all the plans which had been proposed. About a year ago, therefore, under Dr. Letheby's directions, Mr. Haywood, the well-known Engineer to the City Commissioners of Sewers, commenced applying the charcoal filters to the ventilation of the sewers in Shoreditch, and in many of the adjoining streets, which were well known to suffer more from the sewerage exhalations than almost any of the other districts in London. Mr. Haywood employed tolerably thin horizontal charcoal filters, three or four being placed one above the other on a stalk, with short distances between them, the pieces of charcoal being from one inch to an inch and-a-half in length, and placed in single layers, while Mr. Rawlinson, as already mentioned, employed single perpendicular filters. In both cases the results have been perfectly satisfactory, as the sewer gases are as effectually destroyed by being subjected to a species of low combustion, as if they had been passed through a red-hot furnace. In this

process the charcoal is not acted on by the gases, but acts upon them, as before stated, causing them to combine with condensed oxygen. The efficiency of the charcoal appears never to diminish, if it is kept dry and its pores are not choked up by dust.

The expense of applying charcoal to the disinfection of the sewers is by no means considerable, as the first outlay is all that is required. I am informed that the changes rendered necessary by the introduction of charcoal ventilators for the sewers in the extensive district of Shoreditch, have been under £1,000. But had these sewers been originally constructed with a view to the employment of the charcoal ventilators, the expense would have been considerably less.*

One great advantage of the charcoal system is, that it enables us to make as many openings into the sewers as we please, and thus prevents any considerable quantity of the gases accumulating at any one point, as they pass up into the filters and are destroyed almost as rapidly as they are formed. Such sewers have, therefore, all the advantages of open drains, without any of their disadvantages. Hence there can never be any considerable pressure on the traps of the house-drains, one of the great disadvantages attendant on the ordinary system of sewers. It is by no means indispensably necessary that the charcoal filters should be placed only in the

* For all engineering details, I beg to refer the reader to Mr. Haywood, who, I believe, intends reporting on the subject.

ventilating shafts of the sewers. The air-holes in the centres of the streets may be closed, if thought desirable, and the gases conducted by means of wide pipes into charcoal filters, placed at the edges of the pavement, or inserted into the walls of the houses. The lower portions of the lamp-posts enlarged for this purpose, or short pillars like letter-boxes, either standing at the edges of the pavement, or inserted into the walls of the houses, will answer perfectly well. The only precautions to be observed are, that while the filters shall be sheltered from rain and moisture, free access shall be given to the air.

In conclusion I may state, that for the last six years I have strongly recommended that charcoal air-filters should be applied to all house-drains, sinks, and water-closets.

SPECIAL APPLICATION OF THE FILTERS TO WATER-CLOSETS.

Every water-closet, in my opinion, ought to be furnished with a subsidiary pipe branching off from the main pipe, a little below the valve of the closet. This subsidiary pipe should be carried a few feet above the seat of the closet; and its extremity, which should be open, with the exception of a few wires stretched across it, merely to prevent the charcoal falling into it, should terminate in a charcoal filter six or eight inches thick, into which it

should penetrate to the depth of two or three inches, so as, in fact, to be enclosed by a good body of charcoal. Under such an arrangement as this, no foul gases can penetrate into the closet, but will be retained and destroyed by the charcoal, into which they naturally flow, as in this direction scarcely any resistance is offered to their passage; whereas, in almost all water-closets as hitherto constructed, every time that the handle is drawn up, the water which descends necessarily forces a quantity of foul air into the closet, and this foul air not unfrequently passes from the closet into the other apartments of the house.

From the preceding statements it is plain, that the oxygen contained in the air of the atmosphere is by far the cheapest and most effective deodorizing and disinfecting agent with which we are acquainted, and that the usefulness of the charcoal air-filter consists in its affording a safe and advantageous means of applying atmospherical air to disinfecting purposes.

I think it but justice to myself to state that I have no pecuniary interest in the charcoal air-filter. Though strongly urged to do so, I refrained from securing it by patent, on the ground that inventions for the prevention of disease and death ought to be sold at the lowest possible price; and should not, therefore, be encumbered with the expense and restrictions attendant upon patent rights.

I trust the importance of this subject will be my excuse for intruding on your Lordship's notice; and respectfully requesting your Lordship's attention to the accompanying certificates,

I remain,

Your Lordship's obedient Servant,

(Signed) JOHN STENHOUSE, LL.D., F.R.S.,
Late Lecturer on Chemistry at
St. Bartholomew's Hospital.

17, RODNEY-ST., PENTONVILLE, N.
Dec. 11, 1860.

APPENDIX.

Letter from Dr. LETHEBY, Health Officer to the City of London, Lecturer on Chemistry and Medical Jurisprudence in the College of the London Hospital, &c.

GUILDHALL, LONDON,
Dec. 11, 1860.

DEAR DR. STENHOUSE,—

In reply to your question, as to the efficacy of the Charcoal Ventilators which have been put down in the City of London for the Ventilation of the Sewers, I can give you a satisfactory account as far as our experience has yet gone.

As you are aware, in my Report on the Ventilation of Sewers, in September, 1858, I recommended that an experiment should be tried on a large scale with the charcoal, as a means of destroying the noxious gases which, in their passage from the sewers into the public way, were so constantly a source of annoyance and danger. Relying on the practical facts which you had already made public, as to the powerful disinfecting action of charcoal, I had no hesitation in recommending its use to the Commissioners of Sewers of this City. Acting on this advice, their Engineer, Mr. Haywood, put a large district of the City under treatment. He selected the worst district in his jurisdiction, namely, the Eastern Division of the Metropolis; a locality densely populated and inhabited by a very poor class of persons. The area of the experiment is about fifty acres; it has about seventeen hundred houses and 14,500 inhabitants. It is completely isolated, and every opening for ventilation has been provided with a charcoal air-filter. In this way 103 filters have been put down; and although the sewage of the district is extremely bad, yet no unpleasant effects have been observed, either in the atmosphere of the sewers, or on the outside of the ventilators. No hindrance has been offered to ventilation, so that the men can enter the sewers as usual, and the air-filters have completely arrested the flow outwards of the foul gases, so that no offence or annoyance is now observed, except at the gully openings, which have not been provided with charcoal filters. The experiment has been progressing during the whole of the last summer; and although the season has not been as warm as usual, yet the results are sufficiently satisfactory to warrant us in expecting the most complete success.

I may further add, that one of the charcoal ventilators was put up about two years ago, in a locality where the escape of the sewer gases had been a source of great annoyance and injury to health; and notwithstanding that it has been in action for two years, yet it is still as perfect as ever; nothing having been done to it during the whole of that time. It has acted most efficiently in the destruction of the noxious gases.

I am of opinion, from all this, that the employment of your charcoal air-filters will be found of the greatest service in every large town where the sewers must be ventilated.

I remain,
Yours truly,
(Signed) Henry Letheby.

Letter from George A. H. Capes, Esq., Surgeon, late of 22, Philpot-lane, City.

2, Addiscombe Villas, Croydon,
Dec. 12, 1860.

My dear Sir,—

Although I have not the pleasure of personal acquaintance, your labours in the cause of sanitary improvements have made your name familiar.

Some years before I left the City, the state of the sewer in Philpot-lane demanded urgent treatment to abate the stench, of which everybody complained; various remedies were tried, with partial success; and in March and April, 1858, nine or ten deaths occurring almost together, I had several interviews with Dr. Letheby and Mr. Haywood, by direction of the Commissioners of Sewers; and it was agreed a ventilator, containing charcoal on trays, should be erected in Philpot-lane, communicating with the highest point of the sewer; and the present apparatus, resembling in external appearance a dead lantern, was fixed. The effect has been entirely to abate the nuisance, and remove all noxious smell from the locality.

Allow me to add,—for the last eleven years I have continually used peat charcoal in my water-closets in London, with the happiest effect.

I am,
My dear Sir,
Yours very faithfully,
George A. H. Capes.

Dr. Stenhouse.

Letter from William Haywood, Esq., C.E., Engineer to the City of London Commissioners of Sewers.

CITY SEWERS.

Engineer and Surveyor's Office,
39, King-street, Cheapside, E.C.,
Dec. 12, 1860.

Dear Sir,—

I beg to state, in answer to your inquiry, that the experiment of the application of charcoal to prevent the emanations from the sewer ventilators, has now been in operation about five months.*

* I understand the charcoal was introduced into the filters about the end of June, but the charcoal filter particularly alluded to by Dr. Letheby, has been in operation for two years.—J. S.

The area where it is applied is one of the most densely inhabited in the City of London, and comprises about fifty-nine acres; the length of sewers is three miles and a quarter; the number of ventilators, 103.

The season has been so exceptional, that the indications from the experiment have not been so clear as I could wish; but from what has been observed, I consider the result, as far as it goes, to be satisfactory; and that the ventilation of the sewers has not been materially impeded by the application of the charcoal sieves;—if it were so, an additional number of ventilators would rectify that evil.

Truly yours,

William Haywood.

Dr. Stenhouse.

Letter from Robert Rawlinson, Esq., C.E.

34, Parliament-street, Westminster, S.W.,
Nov. 23, 1860.

Dear Sir,—

I am sorry I was not in when you did me the honour to call at my office. It will give me great pleasure to show you my plan of using charcoal for disinfecting sewage gases should you call again. I have applied this mode of sewer ventilation on a large scale at West Ham, near London; at Worksop, at Swansea, and at Buxton (the entire towns); at Brighton partially; at Bowood, the seat of Lord Lansdowne, and at other places. I shall never, in future, execute any sewers or drains without the intervention of charcoal-boxes to burn off the gases at the points of outlet. I gave the City Surveyor, Mr. Haywood, copies of my plans, but do not know if he has used them, or intends to do so. The entire Metropolis may, in my opinion, be freed from sewer gas smell, if charcoal is used as you originally proposed, and as I have applied it. The plan is simple and inexpensive; the material is abundant and cheap. I have not pub-

lished my plans, or in any way attempted to direct public attention to the plan, but determined to avoid discussion and abuse, by executing the work and leaving results to time. I shun patents, and dread being thought an inventor, as I find ten people ready to abuse for one to encourage; and the old cry, "Nothing new in that," &c. &c. &c.

I am,

Your obedient Servant,

(Signed) Robert Rawlinson.

To Dr. Stenhouse, London.

Extract from Mr. Rawlinson's Report on the Completion of Worksop Main Sewerage Works, 4th Dec., 1860.

"The entire system of sewers in Worksop is fully ventilated by special arrangements for this purpose, at fifty-one places, and these include all upper ends of sewers.

"There are side-chambers having screens of charcoal intervening, through which any sewer gases must unceasingly flow; and Dr. Stenhouse has proved that such gases are oxidized by contact with the charcoal, so as to render them innoxious.

"The process is silently carried on continuously, and at very little cost. A few shillings per annum to renew any charcoal which has become wet, and to cleanse out the ventilating shafts from road dirt, which may have worked through the surface grates by the road traffic above, is all that will be required.

"This charcoal-ventilating arrangement is a new feature in town sewering, and Worksop is one of the first towns in which the system has been put into operation."

Additional Observations by R. Rawlinson, Esq., C.E.

"Provision was made in the places named below, at about the dates given.

West Ham,	June, 1858,	about 250 in number.
Brighton,	April, 1859,	4
Worksop,	December, 1858,	51
Swansea,	December, 1859, about	70
Buxton,	January, 1860, „	35
Bowood, the seat of Lord Lansdowne,	January, 1860,	6
	Total number,	416

"Plans were made some time in 1856, by myself, on my return from the Crimea, as I had seen the useful effects of charcoal in the hospitals on the Bosphorus, and in the Crimea, Dr. Stenhouse having gratuitously sent out by the members of the Sanitary Commission, early in the spring of 1855, several of his admirable charcoal respirators.

"Mr. Crozier, Engineer at Sunderland, also used charcoal to disinfect sewer gases in the year 1856.

"Up to this time I have put in use upwards of four hundred charcoal ventilators in sewers executed, and shall continue to use them in future. No sewer should be allowed to be without adequate means for ventilation, and most certainly no ventilator should be without the arrangement of charcoal proposed by Dr. Stenhouse."

By the same Author. Third Edition, price 6d.

A LECTURE

ON THE ECONOMICAL APPLICATION OF CHARCOAL TO SANITARY PURPOSES,

Delivered at the Royal Institution, March 2, 1855.

London: John Churchill, New Burlington Street.

Reed & Pardon, Printers, Paternoster Row, London.

INFLUENCE

OF

MARRIAGE

ON THE

MORTALITY OF THE FRENCH PEOPLE.

BY

WILLIAM FARR, M.D., F.R.S.

Read before the Public Health Department of the National Association for the Promotion of Social Science, 1858.

LONDON:
PRINTED BY SAVILL & EDWARDS, CHANDOS STREET,
COVENT GARDEN.

1859.

INFLUENCE OF MARRIAGE

ON

THE MORTALITY OF THE FRENCH PEOPLE.

THE changes which age induces in the vital forces have been calculated. The differences in the mortality of the two sexes are known. Men have investigated the effects on life of air, water, hills, plains, and marshes—of the sun in various seasons and climates—of food, animal and vegetable—and of alcoholic drinks. The fatality of foul exhalations of every kind has been made manifest.

But the life of man is affected by still more subtle agencies. The action of the various parts of the body in industrial occupations produces specific effects. Every science modifies its cultivators. The play of the passions transfigures the human frame. How do they influence its existence?

These are some of the higher fields of speculation which have not yet been explored by sanitary research. I have now, however, to submit to the department the results of an inquiry into intermediate phenomena.

The family is the social unit; and it is founded in its perfect state by marriage. The influence of this form of existence is therefore one of the fundamental problems of social science.

A remarkable series of observations, extending over the whole of France, enables us to determine for the first time the effect of conjugal condition on the life of a large population.

The French people may be classed in three great groups, exclusive of minors under age:

I. The married, consisting of two groups: (*a*) Husbands, 6,986,223; and (*b*) wives, 6,948,828, making a total of 13,935,051.*

II. The celibate, who have never married—namely, (*a*) Bache-

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* The French census includes many foreign husbands who have left their wives at home. The wives in Great Britain exceeded the husbands by 70,253 in 1851.

lors, 4,031,582; and (*b*) spinsters, 4,547,952, making a total of 8,579,534.

III. The widowed, in two groups: (*a*) Widowers, 836,509; and (*b*) widows, 1,687,583; making a total of 2,524,092.

Deparcieux, in the middle of the last century, investigated the relative mortality of monks and nuns in France; and he compared their life with that of Tontine annuitants, consisting partly of married and partly of unmarried persons. From the age of twenty to forty the mortality of the monks and nuns living in 'single blessedness' was lower, and after the age of forty it was higher than the mortality of the annuitants. The excess of mortality was considerable in the monks. The condition of these members of religious houses is at all times peculiar, and besides their vows of chastity involved a peculiar discipline likely to affect their lives. Many of them lived in Paris. We can now deal with the whole population of France, amounting, in 1851, to thirty-six millions of people, some dwelling against our southern coast, in Flanders, Picardy, and Normandy; some in Brittanny, around the rugged shores of the Atlantic; some in Orleans, Tours, and Nantes, beside the 'murmuring Loire;' some on the Garonne, wandering from Toulouse to Bordeaux, through that old Guienne, famous in our history; some climbing up the Pyrenees, or seated in Languedoc, or in Marseilles on the Mediterranean Sea; some on the rapid Rhone, in Provence, the seat of the old Courts of Love—in Lyons and in Avignon; some extending from the Alps and the mountains of Auvergne and the Vosges, over Dauphiny, Burgundy, Lorraine, and Champagne; and some living in Paris, Rouen, Havre, and the region around the Seine. This country, covered by its millions of small proprietors living on the parcels into which the soil was divided by the great Revolution—by cultivators of the vine and the olive in the South, of the apple and the cereal crops in the North—by pastoral families on the Landes and on the Mountains—by artisans and manufacturers in a few large cities, contained in the year 1851 nearly fourteen million married people of both sexes. What was their rate of mortality? Under the French law, young men of the age of eighteen, and young women of the age of fifteen, can legally marry. Of the few young married pairs living, the mortality in both husbands and wives was excessively high under the age of twenty. Twice as many wives under twenty died in the year as died out of the same numbers of the unmarried; and the mortality was much higher than it was among husbands and wives in the subsequent decennial of life. The result confirms the common opinion of the evil consequences of marriage in many cases under the age of twenty, before the growth of the individual man or woman is completed.

The wives of the next twenty years of age experience a rate of mortality half as high again as the husbands of those ages suffer.

The mortality of the husbands is exceedingly low, 6·5 and 7·1, while wives of twenty to thirty die at the rate of 9·3 in 1000, in

rather higher proportions than the wives of the subsequent age, thirty to forty, when the mortality is 9·1. This excess is fairly ascribable to the sorrows of childbearing, and to no small extent to ignorant midwives.

At the age forty to fifty, the mortality of the husbands (10·3) is slightly higher than the mortality of wives; and so it remains higher ever afterwards, but the difference is not considerable.

Age.	Husbands.	Wives.
50—60	18.3	16.3
60—70	35.4	35.4
70—80	88.6	84.9
80—90	183.6	180.4

Thus, to 1000 husbands living at the age sixty to seventy, there are 35·4 deaths; to 1000 wives, 35·4 deaths. And so the old people go on in the table tottering down the hill till they 'sleep together at the foot.'

How fares it with the unmarried—the celibate?

At the younger ages under twenty, the mortality is, as I have already stated, much lower in the two sexes than it is in the married.

Age. Unmarried.	Males.	Females.
15—20	6·7	7·7 in 1000 die.

At all the ages from 20 to 60 unmarried men experience a much higher rate of mortality than unmarried women. The excess of the mortality of males at the age of 20—30 was in the ratio of 11·3 to 8·7. It was aggravated by the deaths of the soldiers dying in Algeria, and in the Casernes at home; but in the subsequent periods this element does not interfere to any extent.

Annual deaths to 1000 living:—

Ages of the Unmarried.	Males.	Females.
30—40	12.4	10.3
40—50	17.7	13.8
50—60	29.5	23.5

At the age 60 and upwards, the unmarried of both sexes are nearly equally mortal.

But how is it as between the married and the unmarried women?

Why at 20—25 the maidens have the advantage, and the difference is not inconsiderable.

Of 1000 Females.	Married.	Unmarried.
Annual Deaths	9.8	8.5

At the age 25—30 the mortality of the unmarried is slightly in excess (9.2 to 9.0). At the next age (30—40) the wives are the halest; the mortality of the wives being 9.1, and of the unmarried women 10.3. At the age of 40 the married women experience a much lower rate of mortality than the unmarried :—

	Married.	Unmarried.
40—50	10.0	13.8
50—60	16.3	23.5
60—70	35.4	49.8

and so it runs through all ages.

The contrast between the health of the bachelors and of the married men is still more striking ; the young bachelors enjoying an advantage, the old ones suffering in the comparison.

Mortality per 1000 among *married men* and *bachelors* :—

	Married.	Unmarried.
15—20	*29.3	6.7
20—30	6.5	11.3
30—40	7.1	12.4
40—50	10.3	17.7
50—60	18.3	29.5
60—70	35.4	49.9

And after the ages of 80, the mortality of the two classes becomes nearly equal.

If unmarried people suffer from disease in undue proportion, the have-been-married suffer still more. At the ages under 40 the mortality of widows is higher than the mortality of unmarried women. At the earlier ages the mortality is doubled. At 40 and upwards their mortality is lower than the mortality of unmarried women of corresponding ages. At all ages widows are more mortal than wives.

Young widowers under the age of 30, and even under the age of 40, experience a very heavy rate of mortality ; and after 60 the widowers die more rapidly, not only than husbands, but more rapidly than old bachelors.

This is the general result :—Marriage is a healthy estate. The single individual is more likely to be wrecked on his voyage than the lives joined together in matrimony.

In what respect do the married among the masses of the people differ from the unmarried classes ?

Where the earnings of the two classes at the same ages are equal the married man must have a smaller share of the means of living than the single man, for he shares his gains with his wife and children. His food and clothing may be of a lower description, or his lodging be more crowded ; but this is often counteracted by his stimulated industry. The single man can move about more freely, and can carry his industry to the best market. Upon the other hand, his household comforts are less ; the watchful care of a woman does not direct the economy of his dwelling ; the very amplitude of his means exposes him to the temptations of intemperance and vice. His faculties fall, and sometimes rise, into excesses of various kinds.

* This is accidentally an exaggeration ; the facts are insufficient.

The priests and the soldiers represent the unmarried classes. Men of letters, men prosecuting the abstract sciences, men of family and small means, probably figure in large proportion amongst their highest ranks : criminals, lunatics, vagrants, and mendicants among the inferior orders. If they contain some of the lowest, they contain also some of the highest members of their race, ascending from the idiot up to Newton.

The saying of the great Chancellor Bacon has in it a colouring of truth :—'Certainly the best works, and of greatest merit for the public, have proceeded from the unmarried or childless men, who both in affection and means have married and endowed the public.'

The wife shares the fortune of the husband ; he is exposed to violence, she to the incidents of childbearing.

Nuns, religious sisters, many ladies of birth, are at the head ; grisettes, courtesans, at the bottom of the unmarried troops—which figure also in larger proportion than the married among the female criminals, lunatics, idiots, deaf and dumb, blind and deformed. They include some of the loftiest and some of the lowest of their sex.

Is any part of the excessive mortality of the single in France referable to vice ?

Yes ; to vice and its attendant irregularities. Levy asserts that the colleges of France are infested by vices which induce debility, and death later in life. The French youth do not yet engage in strong athletic exercises, which it is well known are the safeguards of our public schools. Syphilis—the oidium of the human race—induces half the sickness, and, indirectly, some of the mortality of the army, which in this respect fairly represents the unmarried population.*

Courtesans die of their various irregularities, but this class of causes operates chiefly in early life.

It is known to everybody that all the species of cultivated plants, and all the breeds of domestic animals, have been greatly improved in Europe. The improvement is partly due to the favourable conditions in which each kind has been placed. It is mainly due, however, to the constant elimination of imperfect types, and to the skilful selection of the finest individuals out of each successive generation. Now the same principle evidently regulates to a certain extent the marriages in France. Cretins do not marry ; idiots do not marry ; idle vagrants herd together, but rarely marry. Criminals by birth and education do not marry to any great extent ; formerly they were executed in great numbers, or they perished in the prisons, and now the galleys interrupt their career.†

The children of families which have been afflicted with lunacy are

* See Acton's works.

† Of 100 French criminals, 60 are unmarried. Two in three suicides are unmarried. Of 1726 women insane, 989 were spinsters, 291 widows, and 397 wives. (Levy, vol. ii. p. 74.)

not probably sought in marriage to so great an extent as others; and several hereditary diseases present practically some bar to matrimony. The beautiful, the good, and the healthy are mutually attractive; and their unions are promoted by the parents in France, who are usually on very friendly terms with their children, and often decide the choice of their daughters too absolutely and with too little reference to the affections. The Chancellor of the Exchequer, in one of his most delightful romances, tells us that falling in love at first sight is the only genuine way in which people do fall in love. But this is not opposed to the theory of selection; for it happens, as we see in the most authentic stories, that the lovers at first sight are invariably full of irresistible charms.

Selection then—not such as the Insurance offices exercise—but a certain selection, does reduce, to some extent, the mortality of the married.

And, upon the other hand, we shall be justified by our medical friends in admitting that a certain number of young women, and young men also, die directly or indirectly of disappointed affection—die of love, in fact. Some destroy themselves; others pine away most piteously; and others register secret vows in heaven never to marry.

Finally, it is held generally that the suppression of a physiological function is prejudicial to health, which our tables confirm, and at the same time qualify. Chastity in itself does not, as in the case of Deparcieux's nuns, raise the mortality of women under forty; and notwithstanding the consequences of vice in the vicious, the selection operating against the unmarried, and the pangs of disappointed love, the mortality of unmarried women in all France is lower than the mortality of married women. After that age the health of the nuns gave way to some extent; but this was, perhaps, as Deparcieux asserts, the consequence in that period of various kinds of austerities, an absence of personal cleanliness, and the want of little comforts which were found in the dwellings of simple artisans who knew how to keep their houses in order. The effects of religious chastity in France have been recently discussed by Dr. Mayer, who with some Catholic authorities contends that it has in itself no prejudicial effect; but this is not the prevalent opinion. Levy professes the contrary doctrine. I cannot discuss this medical controversy here. But the poets, where the affections are concerned, possess an insight almost divine; which is as true in its indications as analytic science. Virginity in the poetical creed was ever proof against danger; the lion would not harm the 'heavenly Una.'

> So dear to heaven is saintly chastity,
> That when a soul is found sincerely so,
> A thousand angels lackey her,
> Driving far off each thing of sin and guilt.

The body partakes of the soul's 'immortal essence;' but no sooner is

'defilement' let into the temple than the life grows 'clotted with contagion.' The reading of the allegory is evident. The poets, however, see all sides of character, and Shakspeare's *Parolles*, a 'great way fool' as he is, says all the evil that physiology has yet suspected in this estate. Lallemand describes vividly the sufferings of the French priests from celibacy—exposed to the fiery ordeal of the confessional. Vows of celibacy on the part of large bodies of young men and of young women are always dangerous; but the question of marriage or of celibacy is a question of temperament and of circumstances—so it is very properly left in England to individuals of full age to decide their lot on their own responsibility, under friendly, or if they please, professional advice. In France there is always a large number of unmarried women of a marriageable age. Thus, in the last returns, 2,231,535 women figure as spinsters, of the age of twenty to forty; the wives of that age numbering 3,200,561.

Is this the result of religious vows, or of the Catholic doctrine of celibacy?—Not to any great extent. In Great Britain the proportions are not very different. Ultimately nine in ten who live marry. The notion that the number of women shut up in convents, had any direct effect in diminishing population was incorrect. In every society large numbers will not, and large numbers should not, marry. They have wide fields of life before them, and public works, devotion, noble foundations, 'friendly love,' will enable them to achieve those triumphs which Bacon has taught us to expect at their hands.

Why is the mortality of young widows and widowers so excessive?

1. They share the pains of the unmarried and they have their own griefs. 2. The pairs, of which one dies prematurely, must in the aggregate be in more unfavourable sanitary circumstances than the rest of the population. 3. The one may take from the other fever, and, in crowded chambers, catarrh, ending in consumption, as the army returns show. 4. The widow with children, especially in France, where there is no poor law, suffers from privation; the widower from a disorderly house. The loss of a beloved wife is the heaviest affliction which a man can sustain. It unsettles many minds. Jacques Bonhomme is left desolate; his wife no longer cheers his home, nurses him in sickness, shares his cares, consoles him, counsels him, loves him. The voice which followed Jacques to the cabaret, and reminded him of the hostages which he had given to fortune, is silent. He plunges into intemperance; vice and disorder follow; his plot of land is torn from his grasp by the mortgagee: his body finds its way to the cemetery; his soul, we may hope, soars to his companion in heaven. For Jacques Bonhomme was solely destroyed by her untimely death.

Children supply in some respects the loss of the dead; and where the surviving are childless they have the resources of their unmarried life to retreat on. But re-marriage is the popular consolation; young widows in health marry at a faster rate than maids, and widowers marry three or fourfold as fast as bachelors. The weakly and sickly are left by this second selection, and swell the apparent mortality of the class. All these disruptions of wedlock, however, leave 'rooted sorrows,' and the day is to be desired when 'Conjux Univira,' or its equivalent, may be inscribed on nearly all tombs.

It is satisfactory to find that by a wise ordinance of Heaven, the fathers and mothers of a nation—those who transmit its life from generation to generation—live long. They sustain their children and live with their grandchildren. Families are thus not detached fragments. The traditions, the works, the thoughts of the nation go on continually; and the common life flows like a mighty river. The immortality of the race on earth is secured by marriage; and mortals in giving seem to receive life from the fountain of life. If 'nuptial love maketh,' it also preserveth mankind.

At all ages after twenty-five, married men enjoy an immunity from illnesses, or their diseases are less fatal than the diseases of the unmarried men of corresponding ages. And wives of the age of forty—after they have nursed children—enjoy a degree of health which neither their selection, nor the vices nor the virtues of the unmarried can explain. Yet we seem to hear the wails of the young mothers dying every year in childbirth. Those sorrows also can be mitigated by science. Through the progress of medicine the deaths of mothers are every year decreasing, and as sanitary science is diffused, by associations like this, they will become uncommon, if none but healthy women marry, and if young persons under age, except in rare exceptional cases, will postpone their marriage at this price—that they are at liberty to prolong what the Vicar of Wakefield called the happiest hours of life.

I have now passed in review the six classes of the population of France, and have ventured to draw some deductions of general application. The French differ from us in some respects; but the English and French nations consist essentially of the same three races—Celts; Franks or Saxons; and Normans—in different proportions, and modified by position and climate. The state of manners among the married is not, we may fairly hope, represented by the common French novels. The French people have among them many vicious, and still many more virtuous characters. The mass of the small agriculturists and of the artisans is moral, yet I trust that in some respects they are excelled by the people of England. I trust that poor widows are better provided for in England than in France, and that the unmarried population in England suffers somewhat less than in France. The husbands and the wives differ in one essential respect from their French neighbours. 6,948,828 wives in France gave birth to 898,254 children annually; 4,329,322 wives in the United Kingdom gave birth to about 809,000 children annually in the years 1849-53; and in the year 1856 the English births probably surpassed the French in numbers. They are our rivals—not our unworthy rivals—in arts, in manufactures, in arms, and in diplomacy. In the increase of population as well as of the power which it represents, and in planting colonies—future

nations—France has been surpassed by England. This the country owes to the numerous children of English parents, who are added to the population, without injury to the health of the father or even of the mother. English mothers are, I believe, as healthy as French mothers; and therefore what we have proved holds in France holds also in England. But it is desirable that the question should be independently investigated in the United Kingdom.

TABLE I. FRANCE.—*Rate of Mortality per Cent. in* 1853.

Ages.	Males.			Females.		
	Unmarried.	Married.	Widowers.	Unmarried.	Married.	Widows.
All Ages.	2.093	1.756	7.249	2.024	1.534	5.804
15—	.668	2.934	18.688	.772	1.364	10.673
20—	1.128	.654	2.877	.874	.930	2.310
30—	1.236	.714	1.849	1.030	.911	1.365
40—	1.774	1.016	2.005	1.381	.999	1.366
50—	2.945	1.830	2.952	2.347	1.627	2.169
60—	4.986	3.544	5.414	4.977	3.540	4.670
70—	10.974	8.859	12.871	11.337	8.490	10.717
80—	21.072	18.363	24.799	24.143	18.044	22.850
90—	28.096	26.016	41.344	29.580	18.778	36.273
100—	76.767	98.674	48.605	45.847	70.505	42.856

The Table may be read thus:—In 1853 to every 100 *Unmarried* men living in France of the age 20-30 there were 1.128 deaths of *Unmarried* men, or 11 in 1000; to every 100 *Married* men at the same age .654 deaths of Married men, or nearly 7 in 1000; and to every 100 Widowers, 2.877 deaths of Widowers, or 29 in 1000.

A correction has been made for increase of population, on the assumption that the increase has been uniform at every age, and that the same rate of increase has taken place since 1851 as was observed between 1846 and 1851. A correction has also been made both in Population and Deaths for ages not stated.

The Tables II. and III. are condensed from M. Legoyt's Official Tables. To him I am indebted for the facts.

TABLE II.—FRANCE. *Population in* 1851 (*vide* '*Statistique de la France,*' *deuxième série, tome II., pp.* 200–1).

Ages.	Males.			Females.			Total.	
	Unmarried.	Married.	Widowers.	Unmarried.	Married.	Widows.	Males.	Females.
All Ages	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0—	[illegible]	—	—	[illegible]	—	—	[illegible]	[illegible]
10—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
60—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
80—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
90—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Not Stated	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30 and upwards	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE III.—FRANCE. *Deaths in* 1853 (*vide* '*Statistique de la France,*' *deuxième série, tome III.,* 1re *partie, pp.* 31–39.)

Ages.	Males.			Females.			Total.	
	Unmarried.	Married.	Widowers.	Unmarried.	Married.	Widows.	Males.	Females.
All Ages	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0—	[illegible]	—	—	[illegible]	—	—	[illegible]	[illegible]
10—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
60—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
80—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
90—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Not Stated	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15—18	[illegible]	—	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18—20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20—25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25—30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ON SOME POINTS

IN THE

COMPOSITION OF WHEAT-GRAIN, ITS PRODUCTS IN THE MILL, AND BREAD.

BY

J. B. LAWES, F.R.S., F.C.S., AND J. H. GILBERT, PH. D., F.C.S.

LONDON:
PRINTED BY HARRISON AND SONS, ST. MARTIN'S LANE, W.C.
1857.

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THE composition of the grain yielding the most important article of human food in temperate climates, its yield of valuable products, and the varying composition either of the grain itself, or of these products, according to the conditions of growth, or the circumstances of after preparation, are subjects worthy the attention equally of states and of men of science. Accordingly we find, that a chemical examination of wheat-grain and its products, has from time to time been undertaken by chemists of repute; sometimes as a matter of private investigation, and at others of public inquiry; and almost as numerous as the names of the experimenters, are the special lines of research which they have selected.

We are indebted to Beccaria for the first notice, more than a century ago, of the gluten in wheat. Among the earlier investigators of the subsequent period, are, Proust, Vauquelin, De Saussure and Vogel, who have examined the proximate principles, and some of the changes to which they are subject, in various descriptions of wheat, of flour, or of bread. M. Boussingault has somewhat elaborately studied various branches of the subject more recently; and we are indebted to Dumas, Payen, Johnston, and Dr. R. D. Thomson for original, as well as a considerable amount of collected information. The most recent, on some points the most detailed, and from advance in methods, perhaps on some also the most reliable, are the results of M. Peligot in 1849, on the proximate constitution of various kinds of wheat, and of M. Millon in 1849 and 1854, on somewhat similar points. Lastly, in 1853 M. Poggiale, and in 1855 Dr. Maclagan, have given the results of their investigations on the characters and composition of bread.

Besides these more general investigations, we have had in recent times many special inquiries connected with our subject. Thus, M. Boussingault has given us analyses of the ashes of wheat; and many other such analyses have been made in Germany, and elsewhere, since the first appearance, in 1840, of Baron Liebig's work on "Chemistry in its Applications to Agriculture and Physiology." In this country, Mr. Way has given us the most extensive series of wheat-grain-ash analyses, his list including those of 26 specimens or descriptions.

The plan of our own investigation, which unfortunately has been much less perfectly filled up than we at first intended, was entered upon more than a dozen years ago, and was devised with reference to the following points:—

1st. The influence of varying characters of season, and of various manuring, upon the organic and mineral composition of wheat grain.

2ndly. The characters of varieties, especially in relation to their adaptation, and the qualities they then develop, under the influence of broader distinctions as to locality, altitude, latitude, and varying climatic circumstances generally.

It is in the second branch of the inquiry that we have fallen the furthest short of our intentions. With a view to its prosecution, a journey through the chief corn growing districts of Europe, commencing at the northernmost point at which wheat is grown successfully, was about to be undertaken in 1848; but the social disturbances on the continent at that period, necessarily prevented it. The plan proposed was—to collect information, as to the geological and meteorological characters of the various localities, as to the mode of culture, and as to the general acreage yield, both in straw and grain; and lastly, to procure characteristic specimens for chemical examination at home. Failing entirely in the execution of this design, the Exhibition of 1851 was looked forward to as an opportunity for procuring specimens not only of wheat, but of other vegetable products, and perhaps also important particulars of their growth, from various countries and climates. Such, however, was the division of authority, and such the alleged preference given to public institutions in such matters, that, whether the latter benefited or not, the collection which we, as private individuals, were enabled to make, was entirely inadequate to our object. From these difficulties it is, that our second main object of inquiry was necessarily to a great extent abandoned; and chiefly for this reason, but partly owing to the pressure of other subjects; the first or more limited or local branch of the investigation has in recent years been but imperfectly followed up. And, as it is probable that it must for some time remain so, it has been thought desirable thus to put on record the results already obtained; hoping that they may serve the double purpose, of confirming or adding to previously existing knowledge, and of indicating to others the points most requiring further study.

The following is a brief outline of the plan of investigation which has yielded the results which we have now to lay before the Society.

From the season 1843–4, up to the present time, wheat has been growing in the same field continuously, both without manure, by ordinary, and by various chemical manures. As a general rule, the same description of manure has succeeded year after year on the same plot of land. The amount of produce, corn, straw, and chaff, and its characters as to weight per bushel, &c., have in every case, been carefully ascertained and recorded. Samples from each plot—both grain and straw—have also been collected every year. Of each of these samples two weighed portions are coarsely ground; the *dry matter* determined at a temperature of 212°; and the *ash* by burning on sheets of platinum, in cast iron muffles arranged for that purpose.* Other weighed portions of grain and straw are partially dried, so as to prevent their decomposition; and in this state they are preserved for any examination of their organic constituents. By this course of procedure, a vast mass of results has been obtained, illustrating the influence of season and manuring, upon the percentage of dry substance, and of mineral constituents, in the produce. In selected cases, the *nitrogen* in the grain, and in the straw, has been determined.

* The dry matter and ash, were not determined in such complete series in the earlier years, as in the later.

A summary table of these dry matter, ash, and nitrogen results, will be given below. In from twenty to thirty cases complete analyses of the grain-ashes have been made, and the results of these will be given in full.

Besides the experiments above described, in selected cases, chiefly from the produce of the earlier years of the field experiments, it was sought to ascertain the comparative *yield of flour*, and also the characters of the flour, of grain grown by different manures in the same season, or by the produce of different seasons. The *colonist's steel handmill* was first had recourse to for this purpose. But it was soon found, that it was extremely difficult so to regulate the machine, as to secure uniform action upon the different grains; and it was further found, that the grain, and especially the bran, was cut up rather than crushed, so as to leave too much of flour in the portion separated as bran, and too much of bran in that separated as flour; and hence the results were not sufficiently comparable with those of the ordinary mill. Arrangements were therefore made for prosecuting the inquiry at a flour mill in the neighbourhood, worked by water power. Weighed quantities of the selected samples (from 125 to 250 lbs. each), were passed through the stones, and the "*meal*" thus obtained, through the dressing machine, under our own personal superintendence; great care being taken to clear from the different parts of the apparatus the whole of one lot, before another was commenced upon.

The yield in the dressing machine of each of the different products was ascertained, and its percentage in relation to the total grain or its "meal," has been calculated. Portions of each of these products have had their dry matter (at 212°), and their mineral matter (by burning on platinum), determined. The percentage of nitrogen in a few selected series—from the finest flour down to the coarsest bran—has also been estimated; and in the same cases, the amounts of one or two of the more important constituents of the ash have also been determined. The results of these dry matter, ash, nitrogen, and constituent of ash determinations, in the series of different products obtained in the mill, will be given in tables further on.

The original design, was to complete the examination of the mill products, by determining in several series of them, the percentage of each of their proximate organic principles; and also the amount and composition of mineral matters, associated with them respectively. It was hoped, by this latter inquiry, to obtain important collateral information, bearing upon the influence of various constituents upon the healthy and special development of the plant. Although, however, specimens of the flour are preserved for this purpose, as well as the ashes of each crude product, it is feared that this subject cannot be proceeded with, at least for a considerable time to come.

Portions of the different products of the dressing machine (including more or less of the finest flour, of the more granular, or of the more branny particles respectively), from grains of somewhat various history of growth, have been experimented upon to ascertain their comparative bread-making qualities; and these results, together with a few examinations of baker's bread, and a discussion of the results of other experimenters, as to the yield of bread from a given amount of flour, and the percentage of water and of nitrogen in the former, will be given below.

With this short outline of the plan of investigation which has been pursued, we proceed now to a discussion of the results which have been obtained.

In Table I. are given, in the first four columns, certain prominent characters of the produce of each of ten years of the successive growth of wheat as above described. The items are:—

The total produce per acre (corn and straw), in lbs.;
The per cent. of corn in the total produce;
The per cent. of dressed corn in the total corn; and,
The weight per bushel of dressed corn in lbs.

The figure given for each year, generally represents the average of about 40 cases; and the characters enumerated are the best which can be given in a summary and numerical form, to indicate the more or less favourable condition of the respective seasons for the healthy development of the crop, and the perfect maturation of the grain.

In the second set of three columns are given, side by side with the general characters just described, the percentages in the grain of each year—

Of dry substance;
Of ash in dry substance; and,
Of nitrogen in dry substance;

the two former items being in most cases the average of 30 to 40 cases in each year; but the per cent. of *nitrogen*, is in each instance, the mean of a few selected cases only.

In the third set of three columns, are given similar particulars relating to the composition of the straw. The percentages of dry substance and of ash in the straw, are however not the averages of so many cases in each year, as are those for the corn; and the determinations of nitrogen in the straw, have also been made in fewer cases than in the grain.

It will thus be seen, that the table affords a summary view of a really enormous amount of experimental result, and we ought to be able by its means to discover, at least the broad and characteristic effects of varying seasons, upon the composition of the crop.* This indeed is all we could hope to attain, in such a mere outline and general treatment of the subject as is appropriate to our present purpose.

TABLE I.

General Summary.

Harvests	Particulars of the Produce.				Composition of Grain.			Composition of Straw.		
	Total corn and straw per acre in lbs.	Per cent. corn in total produce.	Per cent. dressed corn in total corn.	Weight per bushel of dressed corn in lbs.	Per cent. dry (212°.)	Per cent ash in dry.	Per cent. nitrogen in dry.	Per cent. dry (212°.)	Per cent. ash in dry.	Per cent. nitrogen in dry.
1845	5545	33·1	90·1	56·7	80·8	1·91	2·25	..	7·06	0·92
1846	4114	43·1	93·2	63·1	84·3	1·96	2·15	..	6·02	0·67
1847	5221	36·4	93·6	62·0	..	..	2·30	..	5·56	0·73
1848	4517	36·7	89·0	58·5	80·3	2·02	2·39	..	7·24	0·78
1849	5321	40·9	95·5	63·5	83·1	1·84	1·94	82·6	6·17	0·82
1850	5496	33·6	94·3	60·9	84·4	1·99	2·15	84·4	5·88	0·87
1851	5279	38·2	92·1	62·6	84·2	1·89	1·98	84·7	5·88	0·78
1852	4299	31·6	92·1	56·7	83·2	2·00	2·38	82·6	6·53	0·79
1853	3932	25·1	85·9	50·2	80·8	2·24	2·35	81·0	6·27	1·20
1854	6803	35·8	95·6	61·4	84·9	1·93	2·14	83·7	5·08	0·69
Means	5053	35·4	92·1	59·6	82·9	1·98	2·20	83·2	6·17	0·82

Leaving then out of view all minor points, and confining ourselves to our already defined object—namely, that of ascertaining the general direction of the influence of variation of season upon the composition of the wheat crop—we cannot fail to see, that wherever the three items indicating the *quality* of the produce

* It should be stated, that up to 1848 inclusive, the description of wheat was the Old Red Lammas; from 1849 to 1852 inclusive, it was the Red Cluster, and since that time the Rostock. The variations, according to season, both in the characters and composition of the produce, are, however, very marked within the period of growth of each separate description.

markedly distinguish the crop as favourably developed, we have a general tendency to a high percentage of dry substance, and to a low percentage both of mineral matter, and of nitrogen, in that dry substance. This generalization is more especially applicable to the grain; but with some exceptions, mostly explicable on a detailed consideration of the circumstances and degree of its development, it applies to a great extent to the straw also.

Let us take in illustration the extreme cases in the table. The seasons of 1846, 1849, and 1851, with in the cases of the two latter large produce also, give us the best proportion of corn in total produce, more than the average proportion of dressed corn in total corn, and the highest weight per bushel—a very significant character. With this cumulative evidence as to the relatively favourable development and maturation of these crops, we find the grain in two of the cases, to be among the highest in percentage of dry matter; and in the third (1849), though not so high as we should have expected, it is still above the average. The percentages of mineral matter and of nitrogen in the dry substance of the grain, are at the same time, in these three cases, the lowest in the series. The seasons of 1850 and 1854 again, with large amounts of produce, yielded also very fairly developed grain; and coincidently they afford a high percentage of dry substance, and lower percentages both of mineral matter, and of nitrogen, in that dry substance, than the cases of obviously inferior maturation. With some exceptions, it will be seen, that the straws also of these 5 better years, give a tendency to low percentages both of mineral matter and of nitrogen in their dry substance.

Turning now to the converse aspect, the season of 1853, shows itself in the general characters of the produce, to have been in every respect the least favourable to the crop; and it should be added that in this instance (as well as in 1845 to which we shall next refer), the seed was not sown until the spring. In 1853 the produce of grain was small as well as very bad in quality; and with these characters, we have in the grain nearly the lowest percentage of dry matter, and the highest percentage of ash and of nitrogen in that dry matter. In the straw, too, the dry matter is low, the ash somewhat high, and the nitrogen much the highest in the series. In 1845, another year of spring-sowing, and at the same time of very bad quality of produce, we have nevertheless a large *amount* of growth; a fact which tends to explain some of the differences in composition as compared with 1853. Thus, 1845 gives us low percentage of dry matter, but not very high, either ash or nitrogen, in the grain. The straw, however, gives high percentages both of ash and of nitrogen; it being in the latter point next in order to 1853. The seasons of 1848 and 1852 again show low characters of produce. The former has coincidently the lowest percentage of dry matter in the grain in the series; and both have high percentage of ash and nitrogen in the dry substance of the grain. In the straw, the ash is in 1848 the highest, and in 1852 above the average; the nitrogen in dry matter of straw being however in neither instance high.

In several of the cases here cited, there are deviations from our general assumption on one point or other. But an examination in greater detail, would in most or all of them clear up the apparent discrepancy. When indeed, we bear in mind how infinitely varied was the mutual adaptation of climatic circumstances to stage of growth of the plant, in almost every case, it would indeed be anomalous, did we not find a corresponding variation on some point or other, in the characters or composition of the crop. Still, we have the fact broadly marked, that within the range of our own locality and climate, high maturation of the wheat crop is, other things being equal, generally associated with a high percentage of dry substance, and a low percentage of both mineral and nitrogenous constituents. Were we, however, extending the period of our review, and going into detail as to varying climatic circumstances, interesting exceptions could be pointed out.

It may be observed in passing, that owing to the general relationships of the amounts of corn to straw, and the generally coincident variations in the percentages of nitrogen in each, the tendency of all these variations is in a degree so to neutralize each other, as to give a comparatively limited range of difference in the figures, representing for each year, the percentage of nitrogen in the dry substance of the total produce—corn and straw together.

The tendency of maturation, to reduce the percentages of mineral matter, and frequently of nitrogen also, is not observable in corn crops alone. We have fully illustrated it in the case of the turnip; and our unpublished evidence in regard to some other crops, goes in the same direction. The fact is indeed very important to bear in mind; for it constitutes an important item in our study of the variations which are found to exist in the composition both of the organic substance, and of the ash, of one and the same crop, grown under different circumstances. We may particularly observe,

that the obvious reduction in the percentage of nitrogen in wheat-grain, the more, within certain climatic limits, the seed is perfected, is in itself a fact of the highest interest; and it is the more so, when we consider how exceedingly dependent for full growth, is this crop upon a liberal supply of available nitrogen within the soil.

Bearing in mind, then, the general points of relationship which have been established between the characters of the crop as to development and maturation on the one hand, and the percentage amounts of certain constituents on the other, let us now see—what is the general influence of characteristic constituents of *manure*, upon the characters and composition of our wheat crop, which is allowed to remain on the land until the plant has fulfilled its highest function—namely, that of producing a ripened seed?

In illustration of this point we have arranged in Table III, the same particulars as to general character of the crop, and as to the composition of the produce, from several individual plots during the ten years; instead of the average of the series in each year, as in Table I. The cases selected for the comparison are:—

1. A continuously unmanured plot;
2. A plot having an excess of ammoniacal salts alone every year;
3. The average of several plots, each having the same amount of ammoniacal salts as the plot just mentioned, but with it, a more or less perfect provision by manure, of the *mineral constituents* also.

It would be impossible to give the detail supplying all the results collected in this Table III; but perhaps it is only proper that we should do so, so far at least as the percentage of nitrogen in the dry substance of the grain is concerned.

TABLE II.

Determinations of Nitrogen per Cent. in the Dry Matter of Wheat Grain grown at Rothamsted.

Harvests	Experiments. 1	2	3	4	5	Mean.
Unmanured.						
1845	2·28	2·21	2·33	2·30	..	2·28
1846	2·11	2·12	..	..	..	2·11
1847	2·11	2·08	2·22	2·22	..	2·16
1848	2·33	2·34	2·32	2·37	..	2·34
1849	1·85	1·83	1·91	..	..	1·86
1850	2·07	..	2·10	2·07	..	2·08
1851	1·80	1·74	1·89	1·76	..	1·80
1852	2·31	2·23	2·38	2·31	..	2·31
1853	2·26	..	2·33	2·38	..	2·32
1854	2·06	2·06	1·98	1·96	..	2·01
Manured with Ammoniacal Salts only.						
1845	2·18	2·29	2·22	2·23	..	2·23
1846	2·18	2·12	2·29	2·19	..	2·19
1847	2·35	2·29	2·42	2·32	..	2·34
1848	2·39	2·41	2·39	2·49	..	2·42
1849	1·89	..	2·04	1·92	..	1·95
1850	2·13	..	2·08	2·19	..	2·13
1851	2·15	2·12	2·09	2·25	..	2·15
1852	2·41	2·50	2·44	2·58	..	2·48
1853	2·43	2·48	2·37	2·44	..	2·43
1854	2·31	2·22	2·31	2·37	..	2·30
Manured with Ammoniacal Salts and Mineral Manure. (Mixed Plots.)						
1845	..	..	..	..	..	..
1846	2·20	2·14	..	2·14	..	2·16
1847	2·34	2·38	2·40	2·42	2·44	2·40
1848	2·36	..	2·40	2·42	2·48	2·41
1849	1·96	1·97	2·10	2·07	..	2·02
1850	2·16	2·28	2·25	2·25	..	2·23
1851	2·00	1·98	2·02	1·92	..	1·98
1852	2·43	2·34	2·31	2·40	2·32	2·36
1853	2·30	2·34	2·29	2·28	..	2·30
1854	2·16	..	2·12	2·07	..	2·12

It is necessary to make a few remarks in reference to this Table of more than one hundred nitrogen determinations. They were made by the method of burning with soda-lime, and collecting and weighing as platinum salt in the ordinary way. Few, perhaps, who have only made a limited number of such determinations, then only on pure and uniform substances, and who have not attempted to control their work at another period, with fresh re-agents, or by the work of another operator, will imagine the range of variation which is to be expected when all these adverse elements are to have their influence. It is freely granted, that the variations shown in the Table between one determination and another, on one and the same substance, are sometimes more than could be desired. The following, however, are the circumstances under which they have been obtained. Experiments 1 and 2 were pretty uniformly made by the same operator, but not all consecutively, or with the same batch of re-agents. It was thought, therefore, that independently of any variations between the two determinations, it would be desirable to have results so important in their bearings, verified by others. Accordingly, samples of each of the ground grains were given under arbitrary numbers, to two other operators, and their results are recorded respectively in columns 3 and 4; and where a fifth determination is given, it is a repetition by one or other of the experimenters last referred to. We should observe, that we have found it almost impossible to procure a soda-lime that will not give more or less indication of nitrogen when burnt with an organic substance not containing it; and hence we have at length adopted the plan of mixing 1–2 per cent. of non-nitrogenous substance intimately with the bulk of soda-lime, igniting it in a muffle, moistening, and reheating it gently. After this treatment the soda-lime is free from ammonia yielding matter. It should further be remembered, that a ground wheat-grain is by no means an uniform substance. Indeed, as we shall show further on, some of the particles of which such a powder is composed, may contain half as much again of nitrogen as others; and thus any inefficiency in the grinding, or error in taking the portion for analysis, may materially affect the result. Notwithstanding all these circumstances, and the admittedly undesirable range of difference in the several determinations in some cases, it will be observed, that generally three at least of the numbers agree sufficiently closely, and in some cases the fourth also. In fact after all, a study of the detailed table, must give considerable confidence, at least in the direction of the variations between the *mean* results given in Table III, and in their sufficiency for the arguments founded upon them. With these remarks on the data, let us proceed with the discussion of Table III itself, which next follows:

TABLE III.

	Particulars of Quantity.			Particulars of Quality.									Composition of Grain.									Composition of Straw.								
	Total Produce (Corn and Straw) per acre in lbs.			Per Cent. Corn in Total Produce.			Per Cent. Dressed Corn in Total Corn.			Weight Per Bushel of Dressed Corn. lbs.			Per Cent. Dry (212°.)			Per Cent. Ash in Dry.			Per Cent. Nitrogen in Dry.			Per Cent. Dry (212°.)			Per Cent. Ash in Dry.			Per Cent. Nitrogen in Dry.		
	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.	Unmanured.	Ammoniacal Salts only.	Minerals & Ammoniacal Salts.
1845	4153	6346	...	34·7	31·7	...	90·9	90·4	...	56·5	56·2	...	81·2	80·0	80·9	1·93	1·89	1·99	2·23	2·23	...	...	...	...	...	...	...	...	0·92	...
1846	2720	4094	4666	44·4	45·2	43·4	94·7	94·1	93·6	63·7	63·6	63·1	84·0	85·2	84·1	2·03	1·88	1·91	2·11	2·19	2·16	...	...	...	...	...	5·84	...	0·63	0·71
1847	3025	4593	5479	37·1	37·1	36·0	91·6	93·1	93·1	60·9	61·5	62·3	...	...	...	...	...	...	2·16	2·34	2·40	...	...	...	5·97	5·55	5·33	0·74	0·74	0·70
1848	2664	3701	4661	35·7	36·0	36·5	88·8	83·9	89·3	57·3	58·1	58·7	...	81·2	80·4	2·14	2·00	2·02	2·34	2·42	2·41	...	...	...	8·03	6·77	7·01	0·69	0·82	0·84
1849	2813	4092	5619	43·2	42·9	40·5	96·1	94·8	95·4	61·4	62·3	63·7	82·3	82·7	83·0	1·90	1·71	1·81	1·86	1·95	2·02	82·1	83·9	82·5	7·26	6·13	5·97	0·80	0·85	0·82
1850	2721	4810	5877	36·8	35·8	33·2	95·6	94·2	94·2	60·6	60·2	61·2	83·8	84·3	84·4	2·07	1·90	2·01	2·08	2·13	2·23	82·6	85·7	84·4	7·21	5·47	5·67	0·83	...	0·94
1851	2710	5036	5583	40·0	39·0	38·1	89·5	91·0	92·3	61·1	61·9	62·6	84·3	84·5	84·0	1·96	1·82	1·87	1·80	2·15	1·98	84·3	84·9	84·4	6·78	5·58	5·60	0·75	...	0·82
1852	2457	4107	4970	35·0	32·1	30·6	90·9	92·6	92·1	56·6	55·9	56·5	82·6	85·7	83·5	2·11	1·91	1·98	2·31	2·48	2·36	82·8	83·3	82·6	7·41	5·85	5·99	0·93	0·89	0·79
1853	1772	2692	4913	20·2	23·8	26·8	74·3	75·2	89·5	45·9	48·6	51·9	80·1	80·4	80·9	2·42	2·08	2·13	2·32	2·43	2·30	81·6	80·9	81·2	6·50	6·15	5·96	1·27	1·29	1·03
1854	3496	5808	8311	38·9	38·1	34·7	93·9	94·0	95·6	60·6	60·5	61·9	84·7	84·8	85·1	2·01	1·79	1·89	2·01	2·30	2·12	83·3	84·3	84·1	5·26	4·74	4·92	0·75	0·56	0·75
	2856	4608	5561	36·6	36·2	35·4	90·6	90·3	92·8	58·5	58·9	60·2	82·9	83·0	82·9	2·07	1·85	1·66	2·13	2·26	2·22	82·8	83·8	83·2	6·80	5·78	5·81	0·84	0·81	0·82

A glance at this Table III, shows that the *quantity* of produce varies very much indeed in one and the same season, according to the manuring. With these great differences in the *quantities*, dependent on manuring, we have far less marked differences in the *quality* of this ripened crop, dependent on the same causes; and this, with some few exceptions, is the same whether we look to the columns indicating the general characters only, or the composition of the produce. That is to say, the same general distinctions between the produce of one season and another, are observable under the several varying conditions of manuring in each, as have been exhibited in the Table I of averages alone. In fact, season, or climatic variations, are seen to have much more influence than manuring, upon the character and composition of the crop.

We have said that, other things being equal, the percentage of nitrogen in our wheat-grain was the lower the more the seed was perfected; and we have also said, that nitrogenous manures greatly aid the development of the crop. But, an inspection of the columns of Table III which give the percentages of nitrogen in the dry substance of the grains produced under the three different conditions of manuring specified, shows us that there is almost invariably, a higher percentage of nitrogen where ammoniacal salts alone have been employed, than where the crop was unmanured. We also see that, almost invariably, there is a higher percentage of nitrogen where mineral manures as well as ammoniacal salts have been used, than in the produce of the corresponding unmanured plots. A closer examination shows, however, though the indication is not uniform, that there is nevertheless, an obvious tendency to a lower percentage of nitrogen, where the mineral constituents also have been employed, than where the ammoniacal salts have been used alone; and with this, there is on the average, a somewhat higher weight per bushel, indicating higher degree of maturation. Then, again, what are the circumstances of these experiments, under which an increased percentage of nitrogen in the fixed substance of the produce, is obtained by a supply of it in manure? The unmanured plot with its low percentage of nitrogen in produce, is shown by the field experiments, to be greatly exhausted of the annually available nitrogen, relatively to the annually available mineral constituents required by the wheat crop. The plot, with the ammoniacal salts alone, is shown by the field results to be defective in the requisite and available minerals, relatively to the available nitrogen, and hence the crop is grown under a relative excess of the latter. Again, the plots with mineral manures and ammoniacal salts together, received so far an excess of the latter, as to yield, with the minerals, a larger crop than the average of the locality under rotation, and larger also, than the average of seasons would ripen healthily. It is then, under these artificial and abnormal circumstances, of the somewhat unnaturally low percentage of nitrogen, from obvious defect of it in relation to the developing and maturing capabilities of the season on the one hand, and the obviously relative excess of it on the other, that we got an increased percentage of nitrogen in wheat-grain by the use of it in manure. Even under these extreme conditions, the range of variation by manuring is very small; and there is nothing in the evidence that justifies the opinion, that, within the range of full crops and healthy maturation, the percentage of nitrogen in wheat grain, can be increased at pleasure by the use of it in manure. That very opposite extremes of condition of soil-supply, may directly influence the composition even of wheat-grain, is however, illustrated in the percentages of mineral matter, as well as those of nitrogen, given in the table. Thus, taking the mean results only, we have with the relative excess of mineral constituents on the unmanured plot, the highest per cent. in the produce; with the greatest relative defect on the plot with ammoniacal salts only, the lowest per cent. in the grain; and with the medium relation in the other plots, the medium per cent. in the produce. Excepting, however, abnormal conditions, as already remarked, variation in climatic circumstances, has much greater influence on the percentage-composition of wheat-grain, than variation in manuring.

Let us now turn to the composition of the *ash* of wheat-grain. Independently of the defect of a sufficient number of published analyses of wheat-grain ash, a dozen years ago, when we took up the subject, it was then generally believed that the composition of the ash of vegetable produce, would vary considerably with the supplies of the different constituents in the soil; it was thought indeed, that according to the abundance of their presence, one base might substitute another, as for instance *soda, potash,* and so on. About the same time that we undertook a series of wheat-ash analyses, the ashes of various succulent vegetables were also analysed. This latter investigation led us to conclude, that the fixity of the composition of the ash of such substances, depended very much upon the degree of maturation of the produce; and in fact that some constituents—soda and chlorine for instance—occurred in much larger quantities in the more succulent and unripe, than in the more elaborated specimens. It seemed to be perfectly consistent with this experience, to find in the ash of a comparatively perfected vegetable product like wheat-grain, a considerable uniformity of composition—such indeed as the analyses now to be recorded will indicate.

These analyses were made ten years ago by Mr. Dugald Campbell, and the late Mr. Ashford. And as, since that time, the methods of ash-analysis have in some points been improved upon, it will be well to give an outline of the plan then adopted: especially as it is by a consideration of the tendencies to error on some points, that we must interpret the bearings of the actual figures given. On this point we need only add, that Mr. Campbell fully concurs in the tenor of our remarks.

Method of Analysis:—Three portions of ash were taken.

No. 1. In this the sand, silica, and charcoal, phosphate of iron, phosphoric acid, lime, and magnesia, were determined. The ash was dissolved in dilute hydrochloric acid, evaporated to perfect dryness, moistened with hydrochloric acid, boiled with water, and the insoluble matter collected and weighed, as—*sand, silica, and charcoal.* To the filtrate, acetate of ammonia was added, and after digestion, the precipitate separated, dried, ignited and weighed —as *phosphate of iron.* To the filtrate now obtained, a solution of a weighed portion of pure iron dissolved in nitro-hydrochloric acid was added, then acetate of ammonia, and the mixture digested until the whole of the iron was precipitated as phosphate of the peroxide with excess of peroxide, from which was calculated the *phosphoric acid.* From the solution filtered from the phosphate of iron and oxide of iron, the *lime* was separated as oxalate and ignited as carbonate; and from this last filtrate, the *magnesia,* by phosphate of soda and ammonia.

No. 2. A second portion of ash was put into a carbonic acid apparatus, the acid, if any, evolved by means of nitric acid, and determined by the loss. The solution being filtered, sulphuric acid was separated by nitrate of baryta; and afterwards *chlorine* by nitrate of silver.

No. 3. To a solution of a weighed portion of the ash in hydrochloric acid, caustic baryta was added in excess, and the precipitate separated by filtration; the excess of baryta was then removed by carbonate of ammonia, and the filtered solution evaporated to dryness, the residue heated to redness and weighed; water added, any insoluble matter deducted, and the remainder taken as chlorides of potassium and sodium; a solution of chloride of platinum was now added to separate the *potash;* the *soda* being calculated from the loss.

It is now admitted, that the separation of phosphate of iron from the earthy phosphates by acetate of ammonia as above described, is unsatisfactory; and it is probable the amounts given in the tables as phosphate of iron are too high, and if so, part of the difference should obviously go to the earthy bases. For a similar reason it is possible that the phosphoric acid determinations may be somewhat too high—also at the expense of the earthy bases. Then again, it is well-known that in practice the process for potash and soda, is one of some delicacy; and that the tendency of manipulative error is to give the soda somewhat too high. We conclude upon the whole, that our phosphoric acid determinations *may* be somewhat high; our phosphate of iron pretty certainly so; and probably the soda also; the other bases being, on this supposition, given somewhat too low.

The wheat-grain ash-analyses, 23 in number, and referring to the produce of three separate seasons, and of very various manuring, are given in the following Tables—numbered IV, V and VI respectively.

TABLE IV.

Analyses of Wheat-Grain Ash.

HARVEST, 1844.

Plot Numbers	2	3	5	1	9		15	16	18	
Manuring, per acre	Farm-yard Manure; 14 tons.	Unmanured.	Superphosphate Lime, 700 lbs.	Superphosphate Lime, 700 lbs., Rape Cake, 150 lbs.	Superphosphate Lime, 616 lbs. Sulphate Ammonia, 65 lbs.		Superphosphate Lime, Potash and Magnesia, and Silicate Potash.	As 15, with Soda and Sulphate Ammonia, 65 lbs.	As 16, and Rape-Cake, 154 lbs.	Means.
					Analysis 1	Analysis 2				
Characters of the produce:—										
Per Cent. Corn in Total Produce ..	46·4	45·2	46·1	46·4	48·3		46·9	46·8	43·6	46·2
Weight per bushel of Dressed Corn (lbs.) .	59·2	58·5	58·2	59·0	62·2		62·0	62·5	62·0	60·4
Per Cent. Dry Substance in Corn (at 212°)	82·8	81·8	81·1	82·3	83·6		83·1	83·3	83·2	82·65
Per Cent. Ash in Dry Substance ..	2·06	2·17	2·25	1·88	2·00		2·02	2·03	1·96	2·05
Constituents of Ash:—										
Phosphoric Acid	48·13	50·84	51·02	50·48	49·92	49·98	50·39	51·43	49·28	50·16
Phosphate of Iron	2·56	2·45	2·62	2·10	2·32	2·55	3·00	2·54	2·75	2·54
Potass	28·91	30·22	29·37	27·40	29·06	29·45	29·09	28·33	28·53	28·93
Soda	·76	·00	·22	1·12	·90	·00	·00	·00	2·10	·57
Magnesia	11·84	11·04	11·81	10·10	10·84	10·36	10·16	11·38	11·38	11·07
Lime	3·77	3·00	3·18	2·71	3·39	3·73	3·17	3·31	3·48	3·30
Chlorine	Traces	·12	Traces	·52	·15	·11	·09	·21	Traces	·13
Silica, Sand, and Charcoal	2·64	2·72	1·49	5·45	2·57	2·21	1·86	1·47	1·70	2·45
Totals	98·61	100·39	99·71	99·88	99·15	98·39	98·46	98·67	99·22	99·15

TABLE V.

Analyses of Wheat-Grain Ash.

HARVEST, 1845.

Plot Numbers	2	3	5A	5B	6	15	17		Means.
Manuring, per acre	Farm-yard Manure, 14 tons.	Unmanured.	Superphosphate Lime in 1843-44.		Superphosphate Lime 112 lbs. Sulphate Ammonia 112 lbs. Rape Cake 560 lbs.	Bone-ash 224 lbs. Hydrochloric Acid 224 lbs. Sulphate Ammonia 224 lbs.	Superphosphate Lime 224 lbs. Sulphate and Muriate Ammonia, each 112 lbs. Rape Cake 280 lbs		
			Unmanured.	Carbonate Ammonia (Solution).			Analysis 1	Analysis 2	
Characters of the produce :—									
Per Cent. Corn in Total Produce ..	33·4	34·7	34·8	32·5	33·9	34·2	35·4		34·13
Weight per bushel of Dressed Corn (lbs.) .	56·7	56·5	57·5	57·2	57·7	57·5	55·7		56·97
Per Cent. Dry Substance in Corn (at 212°)	80·0	81·2	81·1	80·9	81·7	80·9	80·6		80·91
Per Cent. Ash in Dry Substance ..	1·89	1·93	1·88	1·98	1·92	1·91	1·92		1·92
Constituents of Ash :—									
Phosphoric Acid	47·08	48·69	45·69	47·81	51·56	50·26	51·34	50·01	49·05
Phosphate of Iron	1·97	2·31	3·66	4·58	1·21	1·07	·80	1·20	2·10
Potass	25·16	28·53	29·06	28·87	31·75	32·27	30·20	30·47	29·54
Soda	8·01	·00	6·19	5·01	·00	·00	·68	·00	2·49
Magnesia	11·06	11·58	9·57	8·98	10·14	10·00	10·65	9·96	10·24
Lime	3·66	3·57	3·39	2·02	3·20	3·36	3·06	3·16	3·18
Chlorine	·00	·20	·00	·00	Trace	Trace	·40	·23	·10
Silica, Sand, and Charcoal	3·29	3·39	1·45	1·68	2·36	2·21	2·61	3·40	2·55
Totals	100·23	98·27	99·01	98·95	100·22	99·17	99·74	98·43	99·25

TABLE VI.

Analyses of Wheat-Grain Ash.

HARVEST, 1846.

Plot Numbers	2	3	1	8B	4	11B	Means.
Manuring, per acre	Farm-yard Manure, 14 tons.	Unmanured.	Bone-ash, 224 lbs.	Bone-ash, 224 lbs. Sulphate and Muriate Ammonia, each 112 lbs.	Bone-ash, 224 lbs. Hydrochloric Acid 224 lbs. Sulphate Ammonia, 224 lbs.	Bone-ash, 224 lbs. Sulphuric Acid, 224 lbs. Sulphate and Muriate Ammonia, each 112 lbs.	
Character of the produce :—							
Per Cent. Corn in Total Produce ..	42·7	44·4	43·6	43·6	42·6	43·1	43·3
Weight per bushel of Dressed Corn (lbs.) .	63·0	63·7	62·6	63·6	63·5	63·2	63·3
Per Cent. Dry Substance in Corn (at 212°) .	84·1	84·0	83·3	84·5	84·8	83·9	84·1
Per Cent. Ash in Dry Substance ..	2·07	2·03	2·04	1·91	1·99	1·91	1·99
Constituents of Ash :—							
Phosphoric Acid	50·01	49·89	50·62	49·47	48·73	50·08	49·80
Phosphate of Iron	1·65	1·66	3·10	2·52	2·62	3·06	2·43
Potass	30·03	30·60	27·93	29·58	31·00	29·18	29·72
Soda	·35	·25	·00	·00	·00	·00	·10
Magnesia	11·03	10·97	10·79	11·13	10·43	10·34	10·78
Lime	2·98*	2·89*	4·04	4·63	4·31	4·22	3·84
Chlorine	·12	·09	·30	·34	Traces	·17	·17
Silica, Sand, and Charcoal	1·88	2·17	2·18	2·54	2·62	3·00	2·40
Totals	98·05	98·52	98·96	100·21	99·71	100·05	99·24

* It would seem probable that in these two cases the Lime is given too low; but as the analyst, Mr. Ashford, is dead, no reference can be made, and we have unfortunately not had time to repeat the analyses prior to publication, as we had intended.

It is at once seen, that this ash may be reckoned to contain neither sulphuric acid, carbonic acid, nor chlorine. The latter at least occurred only occasionally, and then in such small quantities, as to lead us to the supposition that its presence is accidental, or at any rate not essential, in the ash of a perfectly-ripened grain. From the frequent absence of soda again, and from the uncertainty in its determinations as above alluded to, we are led to look at it as an equally unessential ingredient in the grain-ash of perfectly ripened wheat. Excluding then the chlorine, the soda, the iron of the phosphate of iron, and that portion of the matter collected as insoluble, which may have been soluble silica—the whole of these, on the average, amounting to a very few per cent.—the ash of wheat-grain is seen to consist essentially of *phosphates only*; the bases being potash, magnesia, and lime. The potash amounts to nearly one-third of the whole ash; the magnesia to rather more than one-third of the potash; and the lime to about one-third of the magnesia.

If we now compare with one another the analyses of the eight different ashes in 1844, those of the seven in 1845, or of the six in 1846, having regard to the manures by which the crops were grown, it is impossible to say that these have had any direct and well-defined influence upon the composition of the ash of the grain. Thus we find, looking at the Table for 1844, that several of the plots manured with superphosphate of lime, yield a grain-ash having no higher percentage of phosphoric acid than that of the unmanured plot. Again, where potash is added (plots 15, 16, and 18), the percentage of it in the ash is not greater than the average of the cases where it was not employed. And again, in the only case where soda was employed (plot 16), there is none of it found in the ash; nor, lastly, is the percentage of magnesia obviously increased by the use of it in manure. A similar detailed consideration of the composition of the ashes of the seasons of 1845 and 1846, would, as already intimated, lead to a similar conclusion. In fact, the variations in the composition of the ash of this supposed ripened product, according to the manure by which it is grown, seem to be scarcely beyond the limits of error in the manipulation of the analysis; though, one case at least of the duplicate analysis of the same ash—namely, that of No. 9, 1844—indicates the range of variation from this cause to have been but small; in the other, (No. 17, 1845) it was somewhat greater.

Although the accuracy of the analyses may not be such as to show the difference in composition, if any, dependent on *manure*, yet it is found to be quite adequate to indicate the marked differences in the *degree of development and maturation* of the grains, dependent upon *season*. Before calling attention to the figures illustrating this point, it should be remarked that the season of 1845 was the worst but one, and that of 1846 nearly the best, for ripening the grain, during the thirteen years of our continuous growth of wheat. And we shall find, consistently with this, and with the conclusions arrived at in connection with Tables I and III, that the variation in the composition of the ash is, comparing one year with another, much the greatest in the produce of the bad ripening season 1845, and much the least in the good ripening season 1846. This point, and some others, are illustrated in the following Summary Table, No. VII.

TABLE VII.

Composition of Wheat-Grain Ash.

	Variation in per Cent. in each Season.			Mean for each Season.			Means according to Manuring.			General Means.	
	1844 9 Cases.	1845 8 Cases.	1846 6 Cases.	1844 9 Cases.	1845 8 Cases.	1846 6 Cases.	Unmanured (3 years).	Farm-yard Manure (3 years).	Other Manures (3 years), 17 Cases.	23 Cases, Rothamsted.	26 Cases, Mr. Way.
Characters of the produce:—											
Per Cent. Corn in Total Produce ..	..	..	..	46·2	34·1	43·3	41·4	40·8	41·3	41·2	
Weight per bushel of Dressed Corn (lbs.) .	..	..	..	60·4	57·0	63·3	59·6	59·6	60·1	60·0	
Per Cent. Dry Substance in Corn (at 212°)	..	..	..	82·6	80·9	84·1	82·3	82·3	82·5	82·4	
Per Cent. Ash in Dry Substance ..	..	..	..	2·05	1·92	1·98	2·04	2·01	1·97	1·99	1·69
Composition of Ash:—											
Phosphoric Acid	3·30	5·87	1·89	50·16	49·05	49·80	49·81	48·41	49·88	49·68	45·01
Phosphate of Iron	·90	3·87	1·45	2·54	2·10	2·43	2·14	2·06	2·45	2·36	0·82*
Potass	2·82	7.11	3·07	28·93	29·54	29·72	29·78	28·03	29·50	29·35	31·44
Soda	2·10	8·01	·35	·57	2·49	·10	·08	3·04	·95	1·12	2·71
Magnesia	1·74	2·60	·79	11·07	10·24	10·78	11·20	11·31	10·51	10·70	12·36
Lime	1·06	1·64	1·74	3·30	3·18	3·84	3·15	3·47	3·43	3·40	3·52
Sulphuric Acid	..	..	..	..		..	..	..	..	..	0·34
Carbonic Acid	..	..	..	..		..	..	..	..	..	0·02
Chlorine	..	..	..	·13	·10	·17	·14	·04	·14	·13	·13
Silica, Sand, and Charcoal	..	..	..	2·45	2·55	2·40	2·76	2·60	2·41	2·47	3·67†
Totals	..	..	..	99·15	99·25	99·24	99·06	98·96	99·27	99·21	100·03

* Peroxide of iron. † Mr. Way gives this as soluble silica, exclusive of the sand and charcoal included with it in our own analyses.

Looking at the first Division of this Table VII, it is seen that in the item of *phosphoric acid*, the variation in the percentage among the several cases in each year, is the greatest in 1845, and the least in 1846; in the *phosphate of iron*, it is the greatest in 1845; in the *potash*, it is the greatest in 1845, much less and about equal, in 1844 and 1846; in the *soda*, it is much the greatest in 1845, and much the least in 1846; in the *magnesia*, it is again far the greatest in 1845, and it is the least in 1846. In the case of the *lime*, we have an exception to this general indication, dependent on the two low amounts of it given for Nos. 2 and 3, 1846; but if these are really in error in the direction suggested at the foot of Table VI, the indication would be the same as for the other constituents. We have then in the circumstances of the seasons, and in the comparative characters of the produce coincident with these variations, the evidence that for one and the same description of grain, in a perfectly matured condition, the composition of the ash will be, within certain narrow limits, constant.

So far as the constituents of the ash of the entire grain of wheat is concerned, we have only further to call attention to the three other Divisions of this Summary Table No. VII. In these are shown, side by side:—

In the second Division of the Table, the mean composition of the ashes for each of the three separate years;

In the third Division, the mean composition for the three years together: (*a*) of the grain-ash from the unmanured plot—(*b*) of that from the farm-yard manured-plot—(*c*) of the grain-ashes from all the other manures during the three years, including 17 cases; and

In the fourth and last Division, the mean composition of all our own wheat grain-ashes analyzed, 23 in number, by the side of the mean of 26 analyses of the grain-ashes of wheat, of different descriptions or grown in different localities, published by Mr. Way.

We will go into very little detail discussions of these mean results, as the points they illustrate have most of them already been alluded to. We may first remark, as a point to which we shall recur further on, that the mean percentage of *lime*, is the least in the bad year 1845, and the greatest in the good year 1846. Again, it is greater in the average from the manured plots, than in that from the unmanured. We may perhaps here anticipate by saying, that this is at any rate consistent with what we shall afterwards have to record, namely, that the ash of the finer flour —of which there is a greater proportion in the grain of the seasons of best maturation—contains more lime than that of the coarser and more branny portions of the grain.

Lastly, in reference to this Summary Table, we would call attention to the mean composition of wheat grain-ash yielded by the 26 analyses given by Mr. Way, by the side of that of the 23 specimens grown at Rothamsted. Mr. Way's analyses, equally with our own, show that wheat grain-ash essentially consists of phosphates of potash, magnesia, and lime. He, however, if we exclude silica, gives higher percentages of base, and a lower one of acid, than our own analyses indicate. Mr. Way's average amount of phosphoric acid is indeed nearly 5 per cent. less in the ash than ours. His series, however, included many descriptions of wheat, and our own only one—the Old Red Lammas. In several of his cases, too, we observe that the percentage of this acid very closely approximates to our own average.

We have now given a summary view of some points of the composition of the entire wheat-grain, and of its ash, as affected by varying season, and various manuring. We next turn to an equally summary statement, of a large number of experiments made in reference to the *yield*, and *composition*, of the various products separated in the milling process. The grains operated upon with this view, were of the same description of wheat, but grown experimentally in different seasons, and under different conditions of manuring.

There have been many observations recorded as to the percentage of flour obtained in practice from 100 parts of grain, and in a subsequent Table some of these will be adduced. We are also indebted to M. Boussingault for the determination of the flour and of the bran, yielded by 24 different descriptions of wheat, all grown side by side in the Jardin des Plantes at Paris. His method was to powder the grains in a mortar, and separate the flour and bran by means of a silken sieve. Results of this kind can, perhaps, scarcely be compared with those of the ordinary mill. The differences exhibited between the different specimens were indeed very great; but the comparisons afforded within the series itself are interesting and very curious.

In our own experiments, the so-called *Colonist's steel hand-mill* was first had recourse to; as it was thought that by its use, rather than that of an ordinary flour-mill, much smaller quantities of grain might be submitted to experiment, and that uniformity of working would also be more within our control. It was soon found, however, that in all cases the grain was, in this steel-mill, rather cut up than crushed and rubbed down, as between ordinary mill-stones. It was also found, that the action in this respect varied considerably according to the speed of the operator, and to the precise set of the mill, which required to be varied according to the character of the grain. From these causes a statement of the *amount of the yield*, of the various products obtained from the steel hand-mill, would be of little value. Though further on we shall have to call attention to some interesting points connected with the comparative composition of the several products of the grains mechanically separated in this way.

We next determined to submit a series of the experimentally grown grains, to careful, and as far as possible, uniform treatment between the stones, and in the dressing apparatus, of an ordinary flour-mill. The mill in question was worked by water-power. From 125 to 250 lbs. of the several grains were submitted to the experiment; the whole of the apparatus being carefully cleared of the products of one specimen before another was commenced upon. The weights and samples of the "*meals*" as furnished by the stones, and of the several products separated in the dressing-machine, were taken under our own personal superintendence. Even here, and although every possible precaution was taken, considerable irregularities in the action of the apparatus were manifest, depending partly on the varying characters of the grain. Indeed it was clear, that to obtain results as to comparative yield of flour, strictly referable to the practical qualities of the respective grains, it would be necessary to operate on much larger quantities of each than those even now taken, in order that the miller might so re-adjust the set of his stones, as the work proceeded, according to the character of the grain and of the meal which it afforded, as to get from each its largest yield, as he would do in working upon considerable quantities. In all, twenty-eight lots of grain were operated upon in this way; and although, as above implied, and as will be pointed out further on, the results might in some points have been somewhat different with larger quantities, yet the miller, after a careful examination of all the products, decided that their general bearings were to be fully trusted.

In some cases the meal obtained from the stones was separated in the dressing apparatus into nine products, and in others the products of the first three wires were taken together, constituting the bulk of the *fine* flour obtainable, and amounting to only about 70 per cent. of the grain. In practice, however, the fourth product of the dressing machine, "*Tails*," is generally redressed, and the fifth, "*Fine Sharps*" or "*Middlings*," reground and redressed, together raising the amount of good bread-flour to about 80 per cent., or sometimes more. The sixth product is called "*Coarse Sharps*;" the seventh, "*Fine Pollard*;" the eighth, "*Coarse Pollard*;" and the ninth, "*Long Bran*." It should be stated, however, that mills vary very much in the arrangement of their dressing machines in different localities, and even in the same locality; so that the exact division of the products here given, will not apply invariably.

In Table VIII are given—

1st. In the upper division of the Table, the percentage yield in 100 meal, of each of the mill products, 7 or 9, as the case may be; each figure being the mean of several experiments.

2nd. (In the middle division of the Table)—The mean per cent. of dry substance (at 212°), in each flour, bran, &c. And,

3rd. The mean per cent. of mineral matter (ash), in each of the same mill products.

As will be seen, seven of the specimens were grown in 1846, nineteen in 1847, and two in 1848; and in order to give some idea of the general character of the produce yielding the results in each of the separate columns, there is given at the head the mean bushels per acre, the mean weight per bushel, and the mean per cent. of corn in total produce, of the specimens to which the column refers.

TABLE VIII.

Showing the yield of the different Mill Products from 100 of Grain; and their Per-centages of Dry Substance and Mineral Matter.

MEAN RESULTS.

	Products of Wires 1, 2, and 3.					Means of all in each year.			Mean of all in the three years; 28 cases.	Distribution of Ash in the several Products of 100 Meal.
	1846		1847		1848					
	Taken separately	Taken together.	Taken separately.	Taken together.	Taken separately.	1846, 7 cases.	1847, 19 cases.	1848, 2 cases.		
General Characters of Produce:—	Mean of 3 cases.	Mean of 4 cases.	Mean of 4 cases.	Mean of 15 cases.	Mean of 2 cases.					
Mean bushels per acre	26¾	29¼	25½	33	31½	28	31½	31½	30¾	
Mean weight per bushel (lbs.)...	63·5	63·3	61·7	62·2	59·1	63·4	62·1	59·1	62·2	
Mean p. c. corn in total produce.	43·5	42·7	35·9	36·0	37·1	43·0	36·0	37·1	37·8	
Yield of Flour, Bran, &c., in 100 Meal.										
1. Wire 1	44·0	...	35·7	...	47·4	44·0	35·7	47·4	41·1	
2. Wire 2	17·9	...	16·4	...	23·9	17·9	16·4	23·9	18·6	
3. Wire 3	8·7	...	13·3	...	2·0	8·7	13·3	2·0	9·2	
Products 1, 2, and 3, together.	70·6	68·3	65·4	71·5	73·3	69·3	70·2	73·3	70·2	
4. Tails	4·6	5·1	7·7	5·3	2·1	4·9	5·8	2·1	5·3	
5. Fine Sharps or Middlings ...	8·7	11·4	10·3	8·3	4·5	10·2	8·7	4·5	8·8	
6. Course Sharps	3·1	3·8	3·6	3·2	2·4	3·5	3·3	3·6	3·4	
7. Fine Pollard	1·8	5·5	1·9	1·8	2·6	3·9	1·8	2·6	2·4	
8. Course Pollard	6·6	2·7	7·4	7·1	7·9	4·4	7·2	7·9	6·5	
9. Long Bran	4·3	2·9	3·2	2·3	5·9	3·5	2·4	5·9	3·0	
Per Cent. Dry Substance (at 212° F.) in each Flour, Bran, &c.										
1. Wire 1	84·4	...	83·8	...	85·4	84·4	83·8	85·4	84·3	
2. Wire 2	84·5	...	83·7	...	85·2	84·5	83·7	85·2	84·3	
3. Wire 3	84·5	...	83·9	...	85·2	84·5	83·9	85·2	84·4	
Products 1, 2, and 3 together.	...	84·7	...	85·8	...	84·6	83·8	85·3	84·1	
4. Tails	84·4	85·2	84·3	85·2	85·5	84·8	85·0	85·5	85·0	
5. Fine Sharps or Middlings ...	83·1	84·9	84·0	84·7	85·3	84·1	84·5	85·3	84·5	
6. Course Sharps	86·5	85·1	82·2	86·2	85·4	85·7	85·3	85·4	85·4	
7. Fine Pollard	87·3	85·8	82·2	85·5	85·7	86·4	84·8	85·7	85·3	
8. Course Pollard	86·4	84·9	82·6	86·0	86·2	85·5	85·3	86·2	85·4	
9. Long Bran	86·3	85·5	83·1	85·6	85·7	85·8	85·1	85·7	85·3	
Per Cent. Mineral Matter (Ash) in each Flour, Bran, &c.										
1. Wire 1	0·70	...	0·68	...	0·70	0·70	0·68	0·70	0·69	·284
2. Wire 2	0·71	...	0·71	...	0·73	0·71	0·71	0·73	0·71	·132
3. Wire 3	0·75	...	0·74	...	0·87	0·75	0·74	0·87	0·73	·067
Products 1, 2, and 3, together.	...	0·71	...	0·70	...	0·71	0·70	0·77	0·71	·483
4. Tails	0·92	1·01	0·93	1·08	1·04	0·97	1·05	1·04	1·03	·054
5. Fine Sharps or Middlings ...	1·82	1·88	1·34	2·43	1·88	1·85	2·24	1·88	2·12	·186
6. Course Sharps	3·77	4·35	3·74	4·43	3·54	4·10	4·28	3·54	4·18	·142
7. Fine Pollard	5·86	6·01	5·45	5·65	5·03	5·94	5·61	5·03	5·65	·136
8. Course Pollard	6·91	6·85	6·41	6·39	5·84	6·88	6·39	5·84	6·47	·420
9. Long Bran	7·63	7·27	6·67	7·19	6·34	7·42	7·08	6·34	7·11	·213
Total	...	...	...	...	...	...	...	...	...	1·634

After the remarks already made, little need be said in detail regarding the comparative yield of the various products by 100 parts of the different meals. It was decided by the miller, that pretty uniformly there was too much flour left in the fourth, but particularly in the fifth product; and this, as an inspection of the Table will show, was obviated in the later experiments, namely, those on the grain of the harvest 1848. So far, then, the variation of the result is more due to the management of the miller, than to the intrinsic character of the grain.

It is more interesting to observe, that a very careful examination of all the products led to the conclusion, that the grains grown by the more nitrogenous manuring, and consequently in the larger crops, *provided they were well developed and matured*,* allowed a better separation of the flour, and less cutting up and intermixture of branny particles with it; and hence, yielded a cleaner bran than the grain of the poorer crops. This was not the case, however, unless the highly-manured crops were at the same time well developed. It is consistent with this character of the grain of the more highly-manured crops, that the produce of the heavier and richer wheat-lands is generally admitted to yield a larger proportion of flour. The fact that the grain of richly-manured crops is frequently coarse, and not the good miller's sample, arises from the circumstance, not of the direct effect of rich manuring in depreciating the quality of the grain, but because the larger crops are more subject to injury due to climatic circumstances, and are consequently frequently less favourably developed and matured.

It will be observed, that the amount of long bran is always more than 2, and in the year of badly-ripened grain (1848), it is nearly 6 per cent. of the total meal. This ninth product, together with the three or four immediately before it in the list, yield us nearly 20 per cent. of the total meal, of such a branny character as seldom to be used for human food. Some of the more recent experimenters, MM. Millon and Peligot for example, have concluded that the amount of actual woody fibre in wheat-grain is seldom more than from 2 to 3 per cent. On this supposition, the nearly 20 per cent. of the grain generally not applied directly as human food, would contain but a small proportion of necessarily indigestible woody matter; and it would appear that there was very great room for improvement in the modes of preparation of the grain, if

* It would appear that, in a good ripening season, this condition is best attained when the crop is cut before the grain is perfectly ripe.

it were desirable to separate as human food in the first instance, a larger proportion of its nutritious matters. M. Poggiale, on the other hand, maintains that the quantity of woody fibre refractory to the digestive organs, though not to chemical agents out of the body, is really very considerable.* But, of some points of the composition of the various products, we shall have to speak more in detail presently.

In the second or middle division of Table VIII, we have the average percentage of dry matter in the different products. In reference to these results it may be noticed, that, as might be expected, the percentage of dry matter is rather higher in the mill products, than it was in the entire grains which yielded them. This is particularly the case in regard to the two specimens of the harvest 1848, the mill products of which give, on the average, a higher per cent. of dry matter than the samples of either of the other two years, although the dry matter of the entire grain of that season (1848), was very low. The differences are therefore obviously more due to the circumstances of preservation and after-treatment, than to distinctions in the character of the respective grains. The only other remark which need be made regarding the varying percentages of dry matter, is, that the branny, or more external portions of the grain, have pretty uniformly a higher percentage of dry matter than the more farinal internal portions.

The widely differing percentages of *mineral matter* in the several mill-products of the same grain, and the variations in this respect, even between the corresponding products in the different specimens, in the same, or in different seasons, are both more striking, and of greater interest.

It is seen, that we have about ten times as high a percentage of ash in the ninth product, or bran, as in the first three, or purer flours. The percentage increases rapidly from the fourth to the ninth—that is to say, the greater the proportion of branny particles. A careful examination of the more detailed Tables also showed, that the variations in the percentage of mineral matter in the corresponding products of different specimens of grain, had a direct relation to the percentage, or relative position of the respective products, in the 100 of meal; in other words, to the

* Since the above was written, a very favourable report has appeared in the "Comptes Rendus" (January 12, 1857), by MM. Dumas, Pelouze, Payen, Peligot, and Chevreul—the Commission appointed by the Academy of Sciences, to inquire into the matter—on a new process of M. Mège Mouriès, which claims to yield a perfectly white, wholesome, and agreeable bread, employing 86—88 per cent. of the entire grain.

proportions of flour or of bran which they respectively contained. Although, however, the *percentage* of mineral matter is so very much greater in those portions of the grain which are not generally used in the first instance as human food, yet, an inspection of the last column of the Table, showing the *distribution* of the mineral matter in the several products of 100 of meal, according to the amount of each of these, will show that, even in our first three products, we have nearly one-third of the whole mineral matter of the grain; and adding to these a certain portion of that in the fourth and fifth products, which frequently contribute to the bread-flour, we shall have more than one-third of it in the currently edible portion of the grain. Further information as to the composition of the respective mill-products, and of their ashes, will be found in Tables IX, X, XI, and XII.

In Table IX are given the individual nitrogen determinations in each of the several mill-products; those in the first three columns being by one experimenter, and those in the fourth column by another. In Table X is given a collective view of the composition of the same products, in regard to some other constituents, as far as they have been determined; including also the mean results of Table IX.

TABLE IX.

Determinations of Nitrogen per Cent. in Mill Products of Wheat-Grain.

HARVEST 1846; GROUND 1848.

Description of Mill Products.	In natural state of dryness.				
	Experiments.				Mean.
	1.	2.	3.	4.	
1. Wire 1	1·59	1·69	1·62	..	1·63
2. „ 2	1·64	1·73	1·69	..	1·69
3. „ 3	1·77	1·78	1·79	..	1·78
4. Tails	1·88	1·86	1·84	..	1·86
5. Fine Sharps, or Middlings ..	2·20	2·20	2·22	2·22	2·21
6. Coarse Sharps	2·58	2·52	2·59	2·62	2·58
7. Fine Pollard	2·43	3·37	2·48	2·48	2·44
8. Coarse Pollard	2·41	2·32	2·47	2·46	2·42
9. Long Bran	2·37	2·37*	..	2·42	2·39

* By a third experimenter.

TABLE X.

Composition of Mill-products of Wheat Grain.

HARVEST 1846; GROUND 1848.

Description of Mill Products.	Flours, &c. from 100 Grain.	In 100 of each Product.			In 100 each Ash.		Distribution of Constituents in Mill Products of 100 Grain.			
		Dry Substance (at 212° F.)	Mineral Matter (Ash).	Nitrogen.	Insoluble in Acid.	Phosphoric Acid.	Mineral Matter.	Nitrogen.	In the Ash.	
									Insoluble in Acid.	Phosphoric Acid.
1. Wire 1	51·2	85·5	0·71	1·63	6·04	44·3	0·36	0·83	0·022	0·161
2. „ 2	24·8	85·6	0·74	1·69	5·83	45·5	0·18	0·42	0·010	0·083
3. „ 3	1·7	85·0	0·82	1·78	5·74	48·1	0·01	0·03	0·000	0·007
4. Tails	1·6	85·2	1·04	1·86	2·18	48·4	0·02	0·03	0·000	0·008
5. Fine Sharps, or Middlings ..	3·3	85·5	2·19	2·21	3·04	51·3	0·07	0·07	0·002	0·037
6. Coarse Sharps ..	3·3	86·1	3·93	2·58	3·84	49·6	0·13	0·08	0·005	0·064
7. Fine Pollard ..	1·8	86·5	5·46	2·44	0·84	52·3	0·10	0·04	0·001	0·051
8. Coarse Pollard ..	6·7	86·1	6·56	2·42	0·56	55·2	0·44	0·16	0·002	0·242
9. Long Bran ..	5·0	86·4	7·14	2·40	0·60	54·8	0·36	0·12	0·002	0·195
Totals ..	99·4	..	..	..	..	..	1·67	1·78	0·044	0·850

The grain to which Tables IX and X refer, was an equal mixture of the produce from four different plots, very variously manured, and grown in the season 1845-6; the harvest of which yielded one of the best-matured grains throughout our series of field experiments. The wheat in question was, however, not ground until 1848; and we have in the percentage-yield of the respective products, confirmation of the general opinion, that other things being equal, old wheat yields up its flour better than new. Thus, whilst in the average of the cases already recorded, we have little more than 70 per cent. of flour through the first three wires, we have from this old wheat 77¾ per cent. The products 4 and 5, from which a further yield of bread-flour is obtained, were correspondingly small; but Nos. 8 and 9 were, on the other hand, somewhat large.

The particulars given in Table X are the percentages of *Dry Matter*, of *Ash*, and of *Nitrogen*, in the respective mill-products of this mixed grain. There are also given the percentages of *Matter insoluble in Acid*, and of *phosphoric acid* in each of the nine ashes; and in the last four columns we have the *distribution* of the total mineral matter, of the nitrogen, and also of the insoluble matter, and phosphoric acid of the ash, in each of the nine products, according to the proportion of the latter in 100 of the grain or meal.

The percentage of *Dry Matter* in the several products from this old grain is, as would be expected, somewhat higher than the average from the grains of the same year which had not been so long stored. As before, the percentage of Dry Matter shows a tendency to increase as we proceed to the outer portions of the grain. The percentages of ash also show the same relations as already pointed out.

Referring to the column of the percentage of nitrogen in each of the nine separated products, we find that it is lowest in the products at the head of the dressing machine—that is, in the flours; and it is half as high again in the more branny portions. It is seen, however, to be the highest of all in the product No. 6; and somewhat lower in the coarser brans. It may be remarked, that the indications of the figures in this respect are at any rate consistent with such observations as have been recorded regarding the structural composition of wheat-grain; it being stated that the greatest concentration of nitrogenous compounds is immediately below the pericarp itself; and we should expect that the longer bran would have less of the more internal matters adherent to it.

The higher percentage of nitrogen in bran than in fine flour, has frequently led to the recommendation of the coarser breads as more nutritious than the finer. We have already seen that the more branny portions of the grain, also contain a much larger percentage of mineral matter. And further, it is in the bran that the largest proportion of fatty matter—the non-nitrogenous substance of highest respiratory capacity which the wheat contains—is found. It is, however, we think, very questionable whether, upon such data alone, a valid opinion can be formed of the comparative values as food, of bread made from the finer or coarser flours from one and the same grain. The published evidence at command leads to the conclusion, that of the nitrogenous constituents of bran, a much larger proportion is soluble in water, than of those in the finer flours. That is to say, there is in the bran, probably, a larger proportion of the more universal vegetable compound, albumen, and less of those more special to the grain of wheat; and hence we may perhaps conclude, that it exists in a less elaborated, and probably, therefore, less assimilable condition.* It is stated, on the other hand, by Poggiale, that a large proportion of the insoluble nitrogenous constituents of bran, occurs in a form only in an inferior degree digestible. Again, it is an indisputable fact, that branny particles, when admitted into the flour in the degree of imperfect division in which our ordinary milling processes leave them, very considerably increase the peristaltic action; and hence the alimentary canal is cleared much more rapidly of its contents. It is also well known, that the poorer classes almost invariably prefer the whiter bread; and among some of them who work the hardest, and who consequently would soonest appreciate a difference in nutritive quality (navvies for example), it is distinctly stated, that their preference for the whiter bread is founded on the fact, that the browner passes through them too rapidly; consequently, before their systems have extracted from it as much nutritious matter as it ought to yield them.

* According to M. Mège Mouriès, before referred to, a portion of the soluble nitrogenous matter of bran exists as a peculiar body, *Cerealine*, which when dissolved up from bran in water at a given temperature, effects the solution of the adherent starch also. His process of extracting from the bran an additional amount of the bread-material which the grain contains, consists in fermenting, after the addition of some glucose, an infusion of the finer brans, straining off the woody matter, and using the fluid in making up the dough with the finer flour.

It is freely granted, that much useful nutritious matter is, in the first instance, lost as human food, in the abandonment of 15 to 20 per cent. of our wheat-grain to the lower animals. It should be remembered, however, that the amount of food so applied, is by no means entirely wasted. And further, we think it more than doubtful, even admitting that an increased proportion of mineral and nitrogenous constituents would be an advantage, whether, unless the branny particles could be either excluded, or so reduced as to prevent the clearing action above alluded to, more nutriment would not be lost to the system by this action, than would be gained by the introduction into the body coincidentally with it, of a larger actual amount of supposed nutritious matters. In fact, all experience tends to show, that the *state*, as well as the chemical composition of our food, must be considered; in other words, that its digestibility, and aptitude for assimilation, are not less important qualities, than its ultimate composition. Observation also tends to show, that elaboration, or maturation, have their influence in determining the digestibility or the assimilability of our food—both the vegetable and animal. But to this point we shall refer again presently.

Returning to the experimental results in Table X, the next point of remark is as to the amount of matter *insoluble in acid*, in the ash of the respective mill-products. It is seen, that the percentage of such matter is very much greater—indeed in this particular case, ten times greater—in the ash of the finest flour, than in that of the coarsest bran. It was at first thought that this must be an error. Some repetitions were therefore made, and the products of the steel-hand-mill were also examined; when it was found that the result in question was fully confirmed. It would be interesting to examine the series, to determine what proportion of this insoluble matter is really proper mineral constituent of the respective products, and how much adventitious merely. On consideration, it will however be clear, that the process of dressing the meal would tend to shake and clean the bran, from all adherent matters; which, if silicious, as well as the particles arising from the abrasion of the mill-stones, would naturally be found among the heavier products at the head of the machine. That is to say, they would be found in larger proportion in the flour, whilst the bran, by the mechanical methods of its separation, would be almost entirely freed from them. According to published analyses, it would appear, however, that *silica*, as distinguished from merely insoluble sandy matter, does exist to a considerable, though variable extent, in the ash of entire wheat-grain. And from the results now given, it may perhaps be concluded, that this constituent found to exist so constantly in some animal substances, does really occur in larger amount in those portions of wheat-grain which are best adapted as food?

Phosphoric acid, on the other hand, is seen to be in smallest proportion in the ash of the flour at the head of the dressing machine; and the percentage pretty gradually augments as we proceed from the finer to the coarser and more branny portions, the ash of the latter being far the richest in this essential acid.*

It may further be remarked in reference to the varying composition of the ash of the different mill-products, that in several series we have found the *magnesia* greatly to increase as we proceed from that of the finer to that of the coarser products. The percentage of *lime* is, on the other hand, greatest in the ash of the flours, and less in that of the brans. This latter point is consistent with a tendency discernible, to an increase in the percentage of lime in the ash of those grains most matured in one and the same season, or in the ash of the grains grown in a season of higher maturing character. We may further conclude, from the great increase in the percentages both of the phosphoric acid, and of the magnesia, as we proceed from the ash of the flours to that of the brans, and also from the very slight compensation from the decrease in that of the lime (the total amount of lime being relatively small), that the chief complementary constituent of wheat-grain ash—namely, *potash*—will occur in larger proportion in the ash of the flours than in that of the brans; hence, its larger amount will be coincident with the larger amount of silica.

In the last Division of Table X is shown the *distribution* in the respective products from 100 of grain, or its meal—of the nitrogen, of the total mineral matter, and of the insoluble substance and phosphoric acid of the latter—which the entire grain contained.

It will be seen, that notwithstanding the percentage of nitrogen is so much greater in the branny products, yet owing to the smaller amount of these, by far the larger proportion of the total nitrogen of the grain is accumulated in the flours. In fact, in the case

* Probably a portion of the phosphoric acid existing in wheat-grain-ash is due to the oxidation, during incineration, of phosphorus, found by Professor Voelcker to exist in such large amount, associated with the nitrogenous bodies. See also Professor H. Rose on this subject—Poggendorff's Annalen, vol. lxxvi. p. 305.

before us about three-fourths of the nitrogen would be accumulated in those of the products which would be ordinarily used for bread, or for human food in other forms. On the other hand, only about two-fifths of the total mineral matter would be found with this three-fourths of the nitrogen. Of the *phosphoric acid* again, the larger amount is distributed in the branny portions; only about one-third of it being obtained in the bread flours. At the foot of these columns of the distribution of the constituents, the percentage in the entire grain or meal of the items as determined by analysis in each separate product, is given by the addition of these items so obtained; and the percentage so calculated agrees very closely with that which the analysis of the entire wheat-grain or its ash would indicate. Thus we may mention, that according to the sum of the phosphoric acid distributed in the different products, we have 50·7 per cent. of it in the ash of 100 of grain or meal; whilst the average percentage obtained in the analyses of the six ashes of the produce of the same season, was 49·8, an approximation sufficiently near to give some confidence, at least in the relative accuracy of the numerous analytical results involved in such an estimate.

Before leaving the question of the comparative chemical composition of the different products obtained by means of mechanical separation from wheat-grain, attention may be called to some results of this kind, in connection with the products of the Colonial steel-hand-mill, which was first employed in these experiments. As will be seen, the results now to be recorded agree in general tendency with those already given; yet they have some special and curious points of interest. The individual nitrogen determinations are given in Table XI, and the collected results of the examination of the various products in Table XII.

TABLE XI.

Nitrogen per Cent. in the Products of Wheat-Grain, from the Colonial Steel-hand-mill.

(In natural State of Dryness.)

Products from	Wheat-Grain, Harvest 1846.					
	Unmanured.			Manured.		
	Experiments.		Mean.	Experiments.		Mean.
	1.	2.		1.	2.	
First Grinding :—						
Wire 1	1·94	1·89	1·91	1·59	1·60	1·59
Wire 2	1·57	1·59	1·58	1·44	1·49	1·47
Second Grinding :—						
Wire 1	1·89	1·90	1·89	1·60	1·61	1·60
Wire 2	1·73	1·78	1·76	1·53	1·65	1·59
Wire 3	1·78	1·76	1·77	1·58	1·49	1·54
Bran	2·07	2·09	2·08	1·69	1·79	1·74

TABLE XII.

Composition of the Products of Wheat-Grain from the Colonial Steel-hand-mill.

Products from	Wheat-Grain, Harvest 1846.								
	Unmanured.					Manured.			Mean of 5.
	In 100 of each Product.			In 100 of each Ash.		In 100 of each Product.			Ash in 100 of each Product.
	Dry Substance (at 212° F.).	Mineral Matter (Ash).	Nitrogen.	Phosphoric Acid.	Magnesia.	Dry Substance (at 212° F.).	Mineral Matter (Ash).	Nitrogen.	
First Grinding.—									
Wire 1	84·0	0·78	1·91	45·3	6·95	84·4	0·78	1·59	0·75
Wire 2	85·2	0·77	1·58	45·0	6·25	83·9	0·79	1·47	0·78
Second Grinding:—									
Wire 1	85·0	1·23	1·89	49·7	9·04	84·8	1·02	1·60	1·22
Wire 2	85·0	1·17	1·76	52·0	9·09	85·3	1·07	1·59	1·24
Wire 3	85·4	1·83	1·77	51·4	11·20	85·4	1·70	1·54	2·01
Bran	86·5	5·76	2·08	53·0	13·57	87·3	5·64	1·75	5·70

It should be mentioned, in reference to the working of the steel-hand-mill, that on passing the grain through the apparatus, four products were first obtained, namely, two fine flours, thirds, and bran; the last two products of the first grinding being mixed together, were passed through the mill a second time, and four products again separated. After this explanation, the designation of the products in Tables XI and XII will be sufficiently intelligible.

With the information derived from the previously recorded results, a glance at the percentages of ash in the several products of the different grains, as given in Table XII, will show that the so-called "bran" here obtained, retained more flour than from the ordinary flour-mill. In fact it was obviously pretty nearly equivalent to the 9th, 8th, 7th, 6th, and part of the 5th products of the ordinary mill taken together. The five flours, on the other hand, but especially the three from the second grinding, obviously contained rather more branny particles than the ordinary bread-flours of the other series of the experiments. Such, indeed, was the obvious character from an inspection of the various products.

Consistently with the character of the products thus defined, the variations in their percentages of nitrogen are, upon the whole, much less than in the former series; but such as they are they are very curious. Thus in both instances, though in a less marked degree in the manured than in the unmanured specimens, the first product of the first grinding, gives a higher percentage of nitrogen than the second; that of the latter being in both cases exceedingly low. In the products of the second grinding, the tendencies are again parallel in the two series. Here again the first product gives a higher percentage of nitrogen than the second. The third is about equal to the second; and the fourth, or bran, is in both series the highest of the six products in this respect. Following up these curious results, which show that the mechanical means employed had the tendency, even within the limits of the farinal part of the grain, to separate products of different chemical characters—we may observe, that the fluctuation in the percentages of *ash*, are in detail strongly confirmatory of the direction of the variations in the amounts of nitrogen. Thus, whether we look to the average percentages of nitrogen and of mineral matter respectively, as influenced by season, and as illustrated in the Summary Table No. I—or to the parallel amounts in the several mill-products as shown in Table X, we see that with a rise in the percentage of nitrogen there is, in comparable cases, one in that of the mineral matter, and *vice versâ*. If with this point in view, and carefully considering the degree of these changes as shown in our more detailed Tables, we compare together the columns of nitrogen and of ash, we find that the fluctuation in the latter as seen in Table XII, are perfectly consistent in direction with those in the former. This is more particularly observable in the products of the unmanured specimen.

The middle Division of Table XII, shows as before, a rise in the percentage of the *phosphoric acid* in the ash, as we proceed from the finer to the coarser products. The *magnesia*, too, follows the same order, the ash of the "*bran*" containing about twice as much as that of the flours of the first grinding.

In the last column of the Table XII, for the sake of comparison with the individual results in the former ones, we have the mean percentage of mineral matter for each product, of five lots of grain which were similarly experimented upon in the steel-hand-mill.

The next step in the prosecution of our inquiry would obviously have been—to separate the different proximate organic compounds, of some series of these grains and their various mill-products—to determine the amount and composition of the mineral matters associated with each—and to submit the different grains, and their mechanically separated parts, to microscopic examination. Had this been accomplished, the results would probably have been of high interest to the vegetable physiologist; and they would probably have tended to throw some light on the functional actions or special offices, of the different mineral constituents known to be essential to the growth and elaboration of vegetable products. This labour, however, from pressure of other investigations, we have hitherto been obliged to forego; though several series of the mill-products themselves (necessarily to a certain degree artificially dried), and also of their respective ashes, have been preserved with a view to the prosecution of the subject, either by ourselves or others, at some future time, as far as such specimens will allow.

A great many scientific observers have investigated the questions—of the practical yield of bread-flour from 100 of grain or meal—of the produce of bread from 100 of flour—of the amounts

of dry substance, of water, and of nitrogenous compounds, in bread—and of the changes which the flour undergoes in the bread-making process. The question as to what are the chemical qualities upon which depend the practical estimate of the miller and the baker, of the comparative values of different flours for the purposes of bread-making, has also frequently been discussed; the conclusion generally arrived at being, that it is the percentage amount of nitrogen or of gluten which rules this practical estimate. The opinion that the comparative value to the *consumer*, too, is measurable by the same standard as to chemical composition, is also pretty universal. With regard to the latter points we may at once observe, that the tendency of more recent investigations is, at least to modify, the currently adopted views. That this was desirable, the whole course of our experimental inquiry and observation, during the last twelve years, has led us to believe; and we have occasionally treated of the subject in some of its aspects elsewhere.

Without hoping to settle dogmatically, questions involving too many factors to be dealt with in such a manner, we propose now to adduce some few experiments and arguments of our own, which may have a bearing upon some of those above enumerated; and we shall also provide as summary a view as possible, in a tabular form, of such published results of others, on some of the points capable of illustration in that way.

In the following Table XIII, are given:—

1st. The results of some experiments of our own, on the amount of bread yielded by 100 of the flour taken from the different parts of the dressing-machine; in some cases using the products of each of the first 4 wires separately, and in others (19 in number), taking the products 1, 2, and 3, mixed together.

2ndly. The determinations (at 212° F.) of the dry substance, and of water, in Country, and in London bakers' loaves.

3rdly. The recorded results of others, on—the yield of flour from 100 of grain—the yield of bread from 100 of flour—and on the percentages of dry substance, and of water, in bread.

TABLE XIII.

Bread made Experimentally.

	Number of Experi-ments.	Particulars of the Grains.				Flour from 100 grain.	Bread from 100 Flour.	In 100 Bread.	
		Harvest.	Bushels per Acre.	Pounds weight per bushel.	Per cent Corn in Total Produce.			Dry Sub-stance.	Water.
Product of Wire 1 ...	6	1846 and 1847	25½	62·3	38·1	37·1	133·9	64·1	35·9
Do. do. 2 ...	6					15·7	135·3	62·5	37·5
Do. do. 3 ...	6					12·9	136·7	61·9	38·1
Do. do. 4 ...	4	1847	25½	61·7	35·9	7·7	136·1	62·6	37·4
Total, or Means...	...	...	...	...	...	73·4	135·2	62·8	37·2
Products 1, 2, and 3, mixed	19	1846 and 1847	32	62·4	37·2	70·8	137·8	61·4	38·6

Baker's Bread.

	Dry Substance	Water
Mean of 4 Country Loaves 8 hours out of Oven	62·1	37·9
Mean of 3 London Loaves 12 hours out of Oven	64·2	35·8
Means	63·0	37·0

Recorded Observations.

	Flour from 100 Grain.	Bread from 100 Flour.	In 100 Bread.	
			Dry Sub-stance.	Water.
PEREIRA	..	128·0		
„	..	134·0		
DAUBENY	82·0			
DUMAS	..	128·0		
„	..	130·0	62·5	37·5
„	..	133·0		
URE—				
Practical Average	..	133·3		
Paris (in 1835) Best Four	80·0	127·0		
HASSALL	77·7			
ALISON AND CHRISTISON (for Scotch Poor Law Board)	..	..	62·0	38·0

Recorded Observations—*continued.*

	Nit. Mat.	Flour from 100 Grain.	Bread from 100 Flour.	In 100 Bread.	
				Dry Sub-stance.	Water.
JOHNSTON—					
English		75·7	150·0	56·0	44·0
English and French Ration		..	..	49·0	51·0
BOUSSINGAULT—					
English		72·0			
French		74·0			
Paris		..	130·0	64·6	35·4
Bechelbronn		..	140·0	57·1	42·9
French Ration		..	139·0		
Syrington		78·0			
Lurzer		83·0			
Dombasle		85·5			
PELIGOT		80·0			
PAYEN—					
Paris, Ordinary		..	..	64·0	36·0
„ „		..	..	62·0	38·0
French Ration		85·0	..	61·0	39·0
„ „		80·0	..	58·0	42·0
English Cubic Loaf		..	..	60·0	40·0
„ „		..	..	52·0	48·0
		Calcd.	Expt.		
MILLON—					
1.		136·0	135·0	65·0	34·98
2.		137·0	137·0	63·4	36·6
3.		131·5	132·0	63·5	36·5
4.		136·0	134·5	61·3	38·7
5.		133·0	133·0	63·3	36·7
6.		134·5	133·0	65·5	34·5
7.		135·0	134·0	66·0	34·0
8.		137·0	137·0	64·9	35·1
9.		133·0	134·0	60·5	39·5
Mean		134·8	134·4	63·7	36·3
Military		..	..	58·0	42·0
„		..	..	57·0	43·0
MACLAGAN—					
Bakers' First Quality ..	7·55	..	134·7	64·25	35·75
„ Second „ ..	7·99	..	..	65·09	34·91
Home-baked, First Quality ..	7·29	..	131·0	66·1	33·9
„ Second „ ..	8·71	..	133·0	58·3	41·7
Unfermented, First „ ..	7·00	..	143·0	60·5	39·5
„ Second „ ..	7·40	..	..	58·5	41·5

Setting aside the incidental but much accounted measure of the quality of flour—colour, it may be said, that the standard of excellence of the baker, is founded on the weight of the loaf, which, consistently with proper texture and lightness, can be obtained from a given weight of flour. Leaving for the present the discussion of the question upon what point or points of chemical composition, these properties individually or collectively depend, we may observe, that so far as our own experiments on the small scale go, the quality of yielding the greatest *weight* of bread from a given amount of flour, certainly did not seem to attach to the highest separated product of the dressing-machine; which, according to the results recorded in Table X, would probably contain slightly the smallest proportion of nitrogen, and consequently the largest amount of the starch series of compounds. On the other hand, looking at the results more in detail than they are given in the Table, it appears that the products of the grain of 1846 gave a notably greater weight of bread than the corresponding products of the more highly nitrogenous grain of 1847—the grain of the former year, being admittedly a somewhat fuller and better sample than that of the latter. Judging then between the different products of the same grain, the experiments showed the weight of bread from a given weight of flour to be greater as we proceed from the less to the more nitrogenous products, so long as the comparison is made between the first three or fine flours only. The fourth product, however, containing still more nitrogen, but probably in a different condition, gave a less proportional weight of bread, notwithstanding that it also contained a considerable amount of branny particles, which it has been stated, have the property of retaining water by virtue of their structure independently of mere chemical composition. Comparing year with year on the other hand, the separate products of the grain of highest weight per bushel, of lower nitrogen, and admittedly of the best development, afforded the largest produce of bread.

Passing from the experiments on the individual products to those on the mixture of the first three of them, which would together constitute a *fine* bread-flour, we see that with this combination there was, on the average, a higher yield of bread than from either of the separate products. This was not the case taking the flours of 1846 alone; but it was remarkably so with those of 1847, the season of rather higher percentage of nitrogen; and it should be added, that whilst on the average the mixed products of

1846 represented only 68·3 per cent. of the entire grain, those of 1847 represented 71·5 per cent. Although, however, there is thus observed a tendency to increase in the *weight* of bread, the higher the percentage of nitrogen within the range of the finer flours, and especially so when mixed, yet the grains and the flours of 1846, were pronounced by an experienced miller, to be superior to those of 1847, and they would doubtless have given, on the large scale, a loaf whiter, lighter, and of better texture.

In all these trials exactly the same treatment was adopted, but as the result may be different in operating upon small and large bulks respectively, the method followed should be described. 32 ounces of flour were taken, and given weighed quantities of compressed yeast, and of salt, were always employed. Water of a uniform temperature was also used, and was worked in by a practised hand, until the dough was decided to be of the proper consistency. The weight of water taken up, was then determined. The dough was always made quite late in the evening, and after being allowed to ferment during the night, it was put into a baker's oven early the following morning. Finally, the loaves were weighed hot from the oven, and again when quite cold, towards evening. From the second weight, the increase upon the original weight of flour was ascertained; and, the percentage of dry substance in the flours being previously known, the percentages of dry matter and water in the bread were calculated, making no allowance, however, for the probably ½ per cent. of dry substance lost by fermentation. The experiments of Millon given in the lower part of the Table XIII, as well as the conclusion of other recent experimenters, indeed seem fully to justify the assumption, that the loss from that cause perhaps need not be estimated at more than the small amount above supposed.

For the sake of comparison, and as a check to our own bread-making experiments, and calculations thereupon, three loaves were bought at random, at as many different bakers in the city of London, and four from as many in our own locality in the country; and upon half of each of these, first finely divided, the dry substance was determined in a water-bath at 212° F. It will be seen, that the mean of our own experiments with the separate products, gives, by calculation as above alluded to, 62·8 per cent. dry substance, and 37·1 water, in the bread; and that with the products 1, 2, and 3 mixed, gave 61·4 dry matter, and 38·6 water.

The four country bakers' loaves (in July 1856—probably from wheat of 1855), gave 62·1 dry, and 37·9 water; and the three London ones 64·2 dry, and 35·8 water. It is thus seen, that our own results from the various flours of grain from two different harvests, agree very closely with those of the country bakers' bread from a third. They, together, indicate an average of 37 to 38 per cent. of water in the bread. The London bakers' loaves, which, however, had probably been four hours longer out of the oven than the country ones, gave 64·2 of dry = 35·8 of water. Upon the whole, then, these experiments, from the flours of three different seasons, indicate a probable average range of from 36 to 38 per cent. of water in bread; and, taking an average of 15 per cent. water in flour, and assuming the loss of dry matter by fermentation, and the gain by fixed saline matter added, to about neutralize each other, this would be equivalent to, from 132·8 to 137·1 parts bread for 100 of flour.

A reference to the recorded results of others, as given in the Table (XIII), will show that this average of 36 to 38 per cent. of water in bread, agrees very closely with the estimate of Dumas; with that of Payen, for the ordinary bread of Paris; with that of Boussingault, for Paris bread; with the mean of four kinds of fermented bread experimented upon by Dr. Maclagan; with that of nine by Millon; and with the estimate of Alison and Christison. The estimate by Payen, of 40 to 48 per cent. of water in the English cubic loaf, is undoubtedly too high for English bakers' bread as usually sold. The estimates by Johnston, of 44 per cent. water in English bread, and of 51 per cent. in English and French ration-bread, are also, no doubt, too high. The results of Boussingault in France agree with our own in England, in showing country bread to contain, usually, more water than that of the cities. Ration-bread seems, according to most observers, to be moister than that in ordinary use. To conclude on this point, although it is very desirable to have a proper estimate of the probable average proportion of dry substance contained in the most important article of the food of our population, yet it is obvious that many circumstances must influence the amount in individual cases. The length of time that the bread has been withdrawn from the oven, must of course be taken into account; but in fixing general averages, perhaps it is better to take it within the first twelve hours, as this will best represent the weights as

delivered by the baker, and, consequently, those estimated as consumed.* It must be remembered, too, that the character of the ripening season greatly affects the quality of the flour, and in giving from the results of others as well as of ourselves, a probable average of 36 to 38 per cent. water, or 62 to 64 per cent. of dry substance in bread, we would at the same time remark, that all our own special data, are derived from experiments on the produce of three seasons of higher than average maturing character.

That the *season*, independently of either soil or manuring, may very much influence the percentage of nitrogen in one and the same description of grain, even in the same locality, is amply illustrated by the results in Tables I and III, given at the commencement of this paper. It cannot be wondered at, therefore, that different localities or countries, should yield us grains showing a wide range of variation in their percentages of nitrogenous compounds. M.M. Rossigneau, Boussingault, Millon, and Peligot have examined many of the characteristic wheats of commerce, and we propose here to subjoin some additional facts relating to this branch of the subject.

In the following Table (XIV) are given the mean results of a great many determinations, by the mechanical method, of the *gluten* in flour, by Mr. W. Constable, of Brighton. It is admitted that this method is an uncertain one, and it is, of course, quite incompetent to indicate the *total nitrogenous* substance of the flours. However, we believe the experiments to have been made with great care and uniformity of manipulation, and, as they are also consistent with results of another kind, they are well deserving record. It may be premised that, whilst the method in question is liable to a little depreciation in the amount of gluten by loss in the washing—especially when the substance itself is of an inferior character—yet, on the other hand, the drying is more likely to be in error in the other direction. These two sources of error, therefore, so far as they operated in the experiments, would tend to neutralize each other. It may be added, that not the least interesting part of Mr. Constable's results, is that he, consistently with the observations of Peligot and others, establishes a very wide range in the *character* of the gluten obtained from different flours,

* It should be stated, however, that, if the fresh weight of the 7 baker's loaves examined were assumed to be 4 lbs. each, as it should have been, then the dry matter which the loaves contained was, on the average, only equal to 60½ per cent; the water, on the same calculation, being, of course, 39½ per cent. !

as to colour, tenacity, elasticity, and so on. Mr. Constable's results, with which he has kindly furnished us, are recorded by him seriatim, in the order in which they were obtained, and without any special reference to the point for the illustration of which we here adduce them. It will be seen that, in our Table, we have classified the results according to their reputed locality of growth or shipment, and arranged the *means* so obtained somewhat in the order of latitude, ranging from north to south, adopting the same general arrangement for the European and American samples respectively.

TABLE XIV.

Percentage of Gluten in different Flours.

MEAN RESULTS.

Reputed Localities of Growth or Shipment.	Number of Experiments.	Mean Gluten Per Cent.
America—		
Canada	6	9·8
Genessee (New York)	7	9·8
Other New York	7	10·1
Ohio	18	11·8
Maryland	3	11·3
Richmond (Virginia)	8	11·8
George Town (South Carolina)	18	13·7
New Orleans	1	13·4
Miscellaneous	11	9·35
Mean	79	11·4
North Europe—		
Dantzig	4	8·9
Hamburg .. .. }		
Stettin .. .. }	8	10·3
Pomerania .. .. }		
South and East Europe—		
Tuscany .. .. }		
Spain .. .. }	8	10·3
Portugal .. .. }		
Black Sea, Soft	2	12·5
Black Sea, Hard	9	14·9
Mean	31	11·6
England—		
White	45	10·8
Red	13	10·4
Not Specified	45	10·5
Mean	103	10·7

It cannot fail to be observed, that there is a general tendency in the specimens from both the European and American continents, to increase in the percentage of gluten, proceeding from the north to the south. It may therefore be concluded that, among other circumstances, a relatively high temperature at the ripening period is favourable to a high per-centage of gluten. The mutual adaptations of heat and moisture, throughout the various stages of the progress of the plant, are, however, so almost infinitely varying, even from season to season, in one and the same locality, that it is not surprising there should be many exceptions to any such sweeping generalization as the one here indicated, in regard to widely differing localities. A study of the variations in the character of the crop, and in the composition of the grain grown from year to year in our experimental field, side by side with the varying circumstances of root and leaf supply of moisture, and of temperature, is sufficient to show how numerous, and how indeed ever changing in their mutual relations, are the factors which lead to one or another order of development in the growing plant.

We have at various times determined the nitrogen in individual specimens of foreign wheat which have come in our way, and recently, through the kindness of Mr. W. J. Harris, of Fenchurch Street, London, we have been provided with a series of characteristic samples, the result of the examination of which we had hoped to embody in this paper. Unfortunately, the laboratory work is not sufficiently completed to allow of this, any further than by a few general remarks on the tendency of the results already obtained. This tendency, from the examination of a series of contrasted samples, is fully to confirm the indications of Mr. Constable's results as to general influence of latitude, or locality, on the nitrogenous per-centage of the grains. There are, however, as above inferred, some interesting and instructive exceptions brought to light. It is obvious, too, that both soil and variety, must have much to do with the character of the grain; and that to elicit without exception, the influence due to climate alone, the same description of wheat should be grown in as far as possible similar soils, in different localities, for a series of years consecutively. In defect of specimens of this kind, we must to a certain extent rely on the assumption, that those descriptions will be generally cultivated in a particular locality, which experience has shown to be most adapted to its climate and other characters, and that hence the qualities of the grains, will be at least some indication of the general tendencies of the climatic circumstances which have yielded them.

It may be remarked, that among the American specimens examined by Mr. Constable, the Genessee is seen to contain the lowest average percentage of gluten, yet it is one of the most highly esteemed of the American flours imported into this country. Again, among the foreign European samples enumerated, the Dantzic yielded the smallest percentage of gluten, whilst it has above all the highest range of value in the English market. The soft Spanish is perhaps the next in order of value among the imported European wheats, and we may observe that it is also one of the lowest in percentage of nitrogen which we have yet examined. On the other hand, the flours from many of the *highly* nitrogenous foreign wheats, have the undoubted character of imparting great "*strength*" to the dough, and for this purpose, they are much valued to *mix* with weaker flour; especially with that from grain which has been imperfectly developed and matured. Some of the most important of these highly nitrogenous wheats are, however, both inferior in the colour of their flour, and very hard and horny; and owing to the inappropriateness of the English method of milling, to the defective whiteness of the flour, and of the bread, and to the somewhat close texture of the latter, other flours of lower percentages of nitrogenous compounds have, notwithstanding this great "*strength*," a higher character when used alone for bread-making purposes. These highly nitrogenous wheats are chiefly imported from Russia, and independently of a high ripening temperature, they are for the most part grown on very rich soil, and sown in the Spring. On this point it is worthy of notice, that home-grown Spring wheat, has sometimes the character of imparting strength to the flour of an inferior Winter wheat, and in the only instance of this kind which we have examined, the reputed stronger (Spring) wheat, had the higher percentage of nitrogen.

It may be stated generally, that the highly nitrogenous foreign wheats, have the admitted character of imparting strength to inferior flour; and they are thus highly valued for the purpose of admixture with home-grown grain imperfectly developed and matured. These highly nitrogenous imported wheats have, as the rule, been matured under a much higher temperature than our own; their nitrogenous constituents would appear to be in larger proportion in the form of gluten; and it is in wheats so ripened,

that the higher percentage of fatty matter is also found, the proper blending of which, according to the experiments of Peligot, considerably affects the physical characters of the gluten. The opinion of Peligot—indeed of other recent investigators, and in this we fully concur—is, that the measure of value of different flours for the purposes of bread-making, is certainly much more dependent on the *condition* of their constituents, than on their mere percentage amount of nitrogenous compounds. This high *condition* of the nitrogenous, and also the other compounds, would seem to be alike possible in wheats of high and of somewhat low percentage of nitrogen—provided, other things being equal, they have been well developed, and ripened at a high temperature; whilst, when this is so, an undoubted preference is given to the less nitrogenous grains. This is partly due to the latter being generally softer, and more amenable to current milling methods; and partly to the widely-differing structural character of the farinal matter, by virtue of which the flour not only makes a better and more workable dough, but the bread produced is of superior texture and lightness—conditions which all analogy would lead us to conclude, must materially aid its digestion and assimilation, and consequently so far increase its value as food.

A high percentage of nitrogenous compounds, provided the grain be well-developed and matured, and not so hard as to offer mechanical obstacles to fine division and easy separation of the bran in the mill, will tend to a great weight of bread, and a good quality as to texture. It would appear, however, that a smaller percentage, if with equally high elaboration, will tend to a similar result as to weight, and to even higher qualities as to texture and whiteness. Within the limits of our own island, however, on the average of seasons, the better-elaborated grain will probably be the less nitrogenous,* though the nitrogenous matter it does contain, will be in a high condition as to elaboration, and to its mutual relations, structural and chemical, with the other constituents of the flour. Hence it comes to pass that, as our home-grown flours go, those which are the best in the view of the baker, will frequently be those having a low *percentage* of nitrogenous compounds—a higher *condition* more than compensating for the

* This is, however, not always the case; and, had we extended our review beyond the ten years to which Tables I and III refer, we should have found, in the season of 1855, both high development and maturation of grain, and high percentage of nitrogenous compounds. Of the cases included in our survey, the season of 1847, afforded in the highest degree the combination of characters here referred to.

higher percentage of nitrogen, generally associated as it is in our climate, with an inferior degree of development and maturation.

We conclude, then, that condition of *maturation*, or perhaps rather *elaboration*, as well as mere percentage composition, should be theoretically, as it is practically, admitted as an essential element in estimating the relative qualities of different wheats or flours, for bread-making purposes. The opinions of some of the most recent, and perhaps the most competent observers, certainly point in the same direction as the one here indicated. Still, the current opinion derived from several of our standard works, would seem to be, that a high percentage of nitrogenous compounds should be taken as an almost unconditional measure of value.

But besides the frequently reiterated statement that the baker's estimate is founded on the amount of the gluten, it is also pretty generally maintained, that it is the amount of this, or of the nitrogenous constituents collectively, which determines the comparative values of different flours or breads, to the *consumer*. With regard to those foreign wheats which have their nitrogenous substance in a highly-elaborated condition, and favourably related to the other matters, and in which the whole is structurally fitted for easy milling, and to yield a light and easily-digestible bread, we would not say that, with such, a comparatively high *percentage* also of the nitrogen, might not be an additional point of value. But, even with the foreign wheats, it is but a small proportion that combine these several qualities; whilst those which have the most of the others, have, generally, less of the *amount* of nitrogenous substance. With home-grown wheats, too, as already said, information at present at command tends to show, that high percentage of nitrogen is, frequently at least, associated with *low condition of elaboration* of the constituents of the grain, yielding an inferior bread-flour—and thus, though from opposite causes to those which depreciate the richer nitrogenous grains of the higher-ripening temperatures, a less valuable food.

Let it be conceded, then, that condition, or elaboration, must affect the digestibility and assimilability of our food. But, we think it may be inferred, yet on other grounds, *that, as flours go*, the richer in the more directly respirable and fat-forming compounds, will generally be more valued as food.* The following Table (for

* There is experimental evidence to show, that the nitrogenous constituents of food may serve one or both of these offices; but, when in excess, probably at a greater cost to the system.

some of the data of which we are indebted to Dr. Playfair), showing the estimated average percentage of nitrogen and of carbon in a number of standard articles of food, and also the relation in them of the one constituent to the other, will aid us in illustrating our meaning :—

TABLE XV.

Estimated Average Composition of Standard Articles of Food.

Foods.	Per Cent.			Nitrogen to 100 Carbon.
	Dry Substance.	Carbon.	Nitrogen.	
Meat (fresh)	45·0	30·0	2·0	6·6
Bacon (green)..	80·0	57·0	1·13	2·0
„ (dried)..	85·0	61·0	1·4	2·3
Suet or Butter	85·0	68·0	0·0	
Milk	10·0	5·4	0·5	9·3
Cheese	60·0	36·0	4·5	12·5
Flour (wheaten)	85·0	38·0	1·72	4·5
Bread	64·0	28·5	1·29	4·5
Maize	87·0	40·0	1·75	4·4
Oatmeal	85·0	40·0	2·0*	5·0
Rice	87·0	39·0	1·0	2·56
Potatoes	25·0	11·0	0·35	3·2
Vegetables (succulent, average) ..	15·0	6·0	0·2	3·3
Peas	85·0	39·0	3·65	9·4
Sugar	95·0	40·0	0·0	
Cocoa and Chocolate	92·0	56·2	2·0	3·6
Beer or Porter	9·5	4·5	0·01	0·2

By this Table it is seen, that wheaten flour and bread contain as high a proportion of nitrogen to carbon as most of the current articles of food of our working population, excepting the important items of fresh meat, milk, and cheese. Were we to ask, to what staple articles the working man next resorts, when his means allow him to add other foods to his main diet of bread?—the answer would be, cheese, bacon, and, perhaps, butter; and we think it would further be, that his preference would generally be for the bacon. The Table shows that, so far as he took cheese, he would considerably increase the proportion of the nitrogen to the carbon he so consumed. The amount of it he would eat would, however, be less than that of bacon, and in the latter he would only consume half as much nitrogen, in proportion to the carbon, as he would in bread alone. In fat, or butter, he would have no nitrogen

* Scotch oatmeal would range higher than this.

at all, so that the addition of either of these to his flour or bread, would still further reduce the proportion of nitrogen to carbon in his food. But all these substances, besides their respirable carbon, have a large proportion of respirable hydrogen, due to their *fatty substance*. Even cheese, which contains the least amount of this, has, nevertheless, a very considerable percentage of it; bacon much more; whilst fat and butter, excluding their water, are, of course, wholly composed of it. If, therefore, we take into calculation the respirable hydrogen, it will be seen that the *respiratory capacity* (so to speak) of the cheese, would be much higher relatively to the *flesh forming*, than the relation to the carbon alone, as in the Table, would indicate. In the bacon, on the other hand, the relation even of the carbon alone to the nitrogen, is much greater than in bread; and, if we further take into account its respirable hydrogen, its respiratory, relatively to its flesh-forming capacity, will appear still greater in comparison with the bread. Lastly, even taking the case of fresh meat, so large is its amount of fat, and, therefore, of respirable hydrogen, that its respiratory and fat-forming, relatively to its flesh-forming capacity, would be much higher, as compared with bread, than the figures in the Table, relating to carbon alone, would show.

From these considerations we think it may fairly be concluded, that the first more urgent call of the system of our under-fed, or only bread-fed, working man, is for an increased supply of respiratory or fat-forming, rather than of flesh-forming, constituents of food. Indeed it is to *fat itself*, in some form, that he first resorts.

If, then, the first demand of the system be generally for more of the more directly respirable or fat-forming material, than bread alone supplies:—if the foreign wheats of more than average percentage of nitrogen have, frequently, structural characters which render them with greater difficulty made into an easily-digestible bread:—if the more highly-nitrogenous wheats of our colder summers have their constituents frequently in a less highly-elaborated condition:—and if, finally, the introduction of more of the nitrogenous constituents of our grain into the bread-flour, generally introduces at the same time branny particles which cause the food to pass in too large a proportion undigested from the body—it would appear, that the standard of value of food-stuffs as they go, according to their nitrogenous percentage, is, at least, only conditionally correct, and that the current views on the point require to be somewhat modified.

From all the data at our command we have adopted 1·29 as the probable average percentage of nitrogen in wheaten bread. That

taken by Dr. Maclagan is from 1·1 to 1·2; and that by Playfair and Payen about 1·1. These amounts represent respectively about 8, 7½, and 7 of nitrogenous compounds.* It will not be supposed that, because, from the facts adduced, we are led to believe that, in addition to such a bread as is here assumed, the first call of the system of the working man would be for more of respiratory and fat-forming material, we would therefore deny the advantage of an increased supply of nitrogenous constituents also. We would, however, submit, as worthy of reflection, that, whilst the relation of nitrogen to 100 of carbon in wheaten flour and bread is 4·5, that in the average of the food consumed, taking eighty-six cases, divided into fifteen classes, and including both sexes and all ages, was only 5·34. These dietaries included many which were exceedingly liberal, so far as the nitrogen supplied was concerned; yet a careful consideration of their details showed that, taking into calculation their respirable hydrogen, the relation of purely respiratory, or fat-forming, to flesh-forming material, in most of these numerous dietaries, would be nearly as great in bread. Indeed, it would appear that, that which is admitted to be a superior class of diet, is distinguished much more by including a certain amount of the important non-nitrogenous constituents, in the condition, and state of concentration, as in fatty matter—and of the nitrogenous ones, in the high condition, as in animal food, than by the higher proportion of its flesh-forming to its more exclusively respiratory and fat-forming constituents.

Appendix.

On the assumption that it is established by others (for we have not ourselves any direct experiments on the point), that the loss of dry substance, by the panary fermentation, is less than one, and, perhaps, less than 0·5 per cent. of that of the flour employed, it is obvious that the number of loaves of a given weight obtained from a sack of flour (280 lbs.) being given, and the per-centage of water in the flour also known, we could easily estimate, within very narrow limits, the per-centage of dry substance in the bread produced. The per-centage of dry matter in bread, thus determined by calculation from the actual or assumed amount in the flour, will be too

* These estimates have reference to the bread from rather fine flour; that from the coarser flours contains rather more of nitrogenous matters.

high by the unknown quantity lost by fermentation, and too low by the amount of salt, or other saline matter, added. On the latter point it may be stated, that about 4 lbs. of salt to the sack of flour is equal to about 1 per cent. in the bread. Indeed, assuming the loss by fermentation as above, and taking such data as we possess as to the usual amount of mineral matter added by the baker, we are disposed to conclude, that the dry matter in bread, calculated as above supposed from the amount of dry substance in flour, and the amount of bread it yields, would be too low by from 0·5—1 per cent., depending on the quantity of the extraneous mineral matter used.

Again, if the whole of the loss by the changes during fermentation be less than 0·5 per cent., and if these, as is known to be the case, mainly affect the non-nitrogenous constituents, we can, in the same way as for the dry matter and the water, estimate pretty exactly the amount of *nitrogen*, or of *nitrogenous compounds*, from the amount of the one or the other in the flour employed.

Frequently, however, the estimates which are given by one and the same authority, for the composition of wheaten-flour and bread respectively, do not seem to bear a proper relation to each other. We have thought, therefore, that it might be useful to give, as an appendix to our paper, a tabular form, showing the yield of bread from 100 of flour, and the per-centages of dry matter, water, nitrogen, or nitrogenous compounds, in the former—assuming any given number of four-pound loaves to be obtained from a sack of flour, and assuming also given probable amounts of water and of nitrogen in the flour. This is accordingly done in Table XVI., which follows.

We need only further say that, with fermented baker's bread of good quality, ninety-five *really four-pound loaves* to the sack of flour, is a yield perhaps very seldom reached.* It would appear, however, from published statements, that of unfermented bread, more than 100 four-pound loaves may be obtained from the sack of flour. It is worthy of remark, that if this be the case, and if the loss by the fermentative process be really so small as is now supposed, the gain in weight by the non-fermenting method, is only a gain of *water retained in the bread*. Unless, therefore, the unfermented bread be better adapted for digestion or assimilation, or be sold at a correspondingly lower price, the consumer will be a considerable loser by the purchase of the unfermented loaf.

* We speak of course of *pure wheaten bread*.

TABLE XVI.

Showing the Composition of Wheaten Bread, calculated from the Quantity of Bread obtained from a given Weight of Flour, and from the Composition of the Flour.*

Number of 4-lb. Loaves obtained from a Sack (280 lbs.) of Flour.	Equal to Bread for 100 Flour.	Per Cent. Dry Matter and Water in the Bread.						Per Cent. Nitrogen, or Nitrogenous Compounds (Gluten, Albumen, &c.), in Bread. (Nitrogenous Compounds = Nitrogen × 6.3).							
		If 16 per Cent. Water in Flour.		If 15 per Cent. Water in Flour.		If 14 per Cent. Water in Flour.		If 1·65 Nitrogen (=10·4 Nit. Compound) per Cent. in Flour.		If 1·7 Nitrogen (=10.7 Nit. Compound) per Cent. in Flour.		If 1·75 Nitrogen (=11·0 Nit. Compound) per Cent. in Flour.		If 1·8 Nitrogen (=11·3 Nit. Compound) per Cent. in Flour.	
		Dry Matter in Bread.	Water in Bread.	Dry Matter in Bread.	Water in Bread.	Dry Matter in Bread.	Water in Bread.	Nitrogen in Bread.	Nitrogenous Compounds in Bread.	Nitrogen in Bread.	Nitrogenous Compounds in Bread.	Nitrogen in Bread.	Nitrogenous Compounds in Bread.	Nitrogen in Bread.	Nitrogenous Compounds in Bread.
90	128·6	65·3	34·7	66·1	33·9	66·9	33·1	1·28	8·06	1·32	8·32	1·36	8·57	1·40	8·82
91	130·0	64·6	35·4	65·4	34·6	66·1	33·9	1·26	7·94	1·31	8·25	1·35	8·50	1·38	8·69
92	131·4	63·9	36·1	64·7	35·3	65·4	34·6	1·25	7·87	1·29	8·13	1·33	8·38	1·37	8·63
93	132·8	63·2	36·8	64·0	36·0	64·7	35·3	1·24	7·81	1·28	8·06	1·32	8·32	1·35	8·50
94	134·3	62·5	37·5	63·3	36·7	64·0	36·0	1·23	7·75	1·26	7·94	1·30	8·19	1·34	8·44
95	135·7	61·9	38·1	62·6	37·4	63·4	36·6	1·22	7·69	1·25	7·87	1·29	8·13	1·33	8·38
96	137·1	61·3	38·7	62·0	38·0	62·7	37·3	1·20	7·56	1·24	7·81	1·28	8·06	1·31	8·25
97	138·6	60·6	39·4	61·3	38·7	62·0	38·0	1·19	7·50	1·23	7·75	1·26	7·94	1·30	8·19
98	140·0	60·0	40·0	60·7	39·3	61·4	38·6	1·18	7·43	1·21	7·62	1·25	7·87	1·29	8·13
99	141·4	59·4	40·6	60·1	39·9	60·8	39·2	1·17	7·37	1·20	7·56	1·24	7·81	1·27	8·00
100	142·8	58·8	41·2	59·5	40·5	60·2	39·8	1·15	7·24	1·19	7·50	1·22	7·69	1·26	7·94
101	144·3	58·2	41·8	58·9	41·1	59·6	40·4	1·14	7·18	1·18	7·43	1·21	7·62	1·25	7·87
102	145·7	57·6	42·4	58·3	41·7	59·0	41·0	1·13	7·12	1·17	7·37	1·20	7·56	1·23	7·75
103	147·1	57·1	42·9	57·8	42·2	58·5	41·5	1·12	7·05	1·15	7·24	1·19	7·50	1·22	7·69
104	148·6	56·5	43·5	57·2	42·8	57·9	42·1	1·11	6·99	1·14	7·18	1·18	7·43	1·21	7·62
105	150·0	56·0	44·0	56·7	43·3	57·3	42·7	1·10	6·93	1·13	7·12	1·17	7·37	1·20	7·56

* The Figures in the Table should, of course, be taken subject to the qualifying remarks which have been made. It is obvious that the Form can easily be extended to include any further or intermediate ranges of produce of bread, or composition of Flour.

ON

THE CHEMISTRY OF THE FEEDING OF ANIMALS

FOR

THE PRODUCTION OF MEAT AND MANURE.

BY J. B. LAWES, F. R. S., F. C. S.

[Read before the Royal Dublin Society, Thursday Evening, March 31, 1864.]

THE breeding and feeding of stock must always constitute an important branch of the agricultural practice of this Island. With a climate rarely so hot and dry in summer, or so cold in winter, as to materially arrest vegetation, Ireland may not less truly than poetically be styled the Emerald Isle. A succession of seasons more than usually unfavourable for grain crops has greatly reduced the profits, and even the capital, of many of your farmers. It is natural, therefore, that there should be, at the present time, more attention directed to the production of meat, and less to the growth of corn; more especially as with the declining price of grain that of meat has considerably advanced, and has probably not yet reached its highest point.

Although the application of science to agriculture is not generally regarded with much favour by practical farmers, there are still very many who feel how advantageous it would be to know more of the rationale of their operations than they do at present. The scientific principles involved even in old-established practices are frequently but little understood; whilst farming is every year becoming less and less of a mere routine business than it was formerly: new foods, new manures, improved descriptions of stock and seed, and new mechanical appliances are constantly being introduced, requiring more knowledge and discrimination in their selection and use.

The particular branch of agriculture upon which I have the honour to address you this evening is that of the production of *meat* and *manure*. We all know that when fattening animals are supplied with a sufficient amount of proper food they increase in weight, a portion of the food being fixed or stored up in the body; that other portions are rejected by the animal in the liquid and solid form, and serve as manure;

and that others are expended or lost in the processes of respiration and cutaneous exhalation. Experience also teaches us that some foods have higher feeding values than others, and it is generally supposed that with a difference in feeding properties there will also be a difference in the value of the manure.

It is the province of agricultural chemistry to determine what proportion of the several constituents of the food consumed will be stored up in the form of meat, and how much will remain as manure, according to the description of animal, and the kind of food employed, and so to provide the means of estimating the value of the respective products of the feeding operation. To this end, it is necessary to determine, by means of careful analysis, the composition of the foods consumed, of animals in the store or lean and in the fat condition, and of the manurial matters voided. Such an undertaking is, however, by no means a light one, and it can only be carried out with any prospect of success by the conjoint aid of experiments on a large scale in the feeding-shed, and of investigations in the laboratory, involving a great amount of analytical labour, and requiring the observance of all the refinements of method which modern science permits.

I propose to bring before you a condensed summary of some of the results which have been obtained in experiments made at different times during the last twenty years, at my farm and laboratory, at Rothamsted, in Hertfordshire. There are, it is true, many points which are not as yet satisfactorily cleared up, and some of these are still under investigation. The figures given in the tables, in most cases, however, represent the results obtained in careful experiments with large numbers of animals of each of the descriptions indicated, and they may be taken as showing what should be the average result obtained in ordinary farm practice, when animals of fair quality are fed liberally for the butcher.

Composition of Oxen, Sheep, and Pigs, in the Store and Fat Condition.

For the purposes of my illustration, I shall assume that an ox or a sheep will increase in weight by about one-half, and that a pig will double its weight during the so-called fattening period. Accordingly, I shall direct your attention to the composition of each of these descriptions of animal when in the lean or store, and also when in the fat condition, after it has increased in the proportion above supposed. I shall then show the average amount of food required to produce 100 lbs. increase in live weight, and also the composition of the food, of the increase, and to some extent of the manure also; and in doing so I shall assume that the animals are liberally supplied with good fattening food; for it should be borne in mind that, as a large amount of the food is expended to maintain the respiration of the animal, the proportion of this expenditure or loss to the amount of saleable increase obtained will be the greater the longer the period required for the production of the increase, and hence it will be the greater if the food be inferior in quality, or stinted in amount.

With these preliminary remarks, I will now direct attention to the tables.

TABLE I.—*Composition, per cent., of Oxen, Sheep, and Pigs, in the Store and in the Fat Condition.*

	Oxen.		Sheep.		Pigs.	
	Store.	Fat.	Store.	Fat.	Store.	Fat.
Nitrogenous substance, ...	18·0	15·0	15·0	12·5	14·0	10·5
Non-nitrogenous substance (fat), .	16·0	30·0	18·0	33·0	22·0	44·0
Mineral matter, ...	5·2	4·0	3·5	3·0	2·8	1·8
Total dry substance, ...	39·2	49·0	36·5	48·5	38·8	56·3
Water, ...	60·8	51·0	63·5	51·5	61·2	43·7
Total, ...	100·0	100·0	100·0	100·0	100·0	100·0

Table I. shows the composition, per cent., of oxen, sheep, and pigs, both in the store and in the fat condition, the constituents given being the nitrogenous substance (lean), the non-nitrogenous substance or fat, the mineral or incombustible matter, the sum of these or total dry substance, and the water.

Taking first the nitrogenous substance, it is seen that in each description of animal there are several per cent. less of it in the fat than in the store condition. Of fat, on the other hand, there is in the case of both the oxen and the sheep nearly, and in that of pigs fully, twice as much in 100 lbs. live weight of the fat, as in the same weight of the store animals. The mineral matter, again, like the nitrogenous substance, is found in less proportion in the fat than in the store animal. Lastly, the proportion of total dry substance is seen to be considerably increased, and that of the water diminished, as the animal passes from the lean to the fat condition.

In fact, the fattening process may be said to consist mainly in the diminution of the proportion of water, and the increase of that of fat. The actual amounts of both the nitrogenous and the mineral matter do, indeed, augment during the fattening process, as will be seen presently, when I come to speak more directly of the composition of the increase itself; but as they do so in so much less proportion than the fat, it results that their proportion in a given live weight becomes less and less, whilst that of the fat increases as the animal matures.

The quality of the meat depends, however, much upon the distribution and the character of the fat deposited as well as upon its amount. Different breeds store up their fat very differently—some more outside upon the carcass, some more around the internal organs, some in more intimate mixture with the nitrogenous or fleshy portion of the meat, and so on. Then, again, complaints are sometimes heard of the fat, particularly of pork, boiling away. Such faulty deposition is generally attributable to the character of the food, and is found to result when too much oily matter is given, or when pigs are fed freely with roots or other succulent food.

Proportion of Parts, in Animals of different Descriptions, and in different Conditions of Maturity.

Passing from the question of the chemical composition of oxen, sheep, and pigs, it will be desirable, before considering the relation of the increase and manure produced to that of the food consumed, briefly to point out some characteristic differences of structure or relative proportion of certain of their internal organs, as in these will be found the key to the difference in the character and amount of food which the three descriptions of animal respectively require. Table II. illustrates this part of the subject.

TABLE II.—*Relation of Parts in Animals of different Descriptions, and in different Conditions of Maturity.*

	Per Cent.					
	In different Animals.			In Sheep in different Conditions.		
	Oxen.	Sheep.	Pigs.	Store.	Fat.	Very fat
Average of	16	249	59	5	100	45
Stomachs and contents, ...	11·6	7·5	1·3	9·1	7·0	5·6
Intestines and contents, ...	2·7	3·6	6·2	5·3	3·8	2·8
	14·3	11·1	7·5	14·4	10·8	8·4
Internal loose fat, ...	4·6	6·9	1·6	4·5	6·0	7·5
Heart, aorta, lungs, windpipe, liver, gall-bladder and contents, pancreas, spleen, and blood, . . .	7·0	7·3	6·6	8·4	7·7	6·5
Other offal parts, ...	13·0	15·0	1·0	17·9	16·1	13·1
Total offal parts, ...	38·9	40·3	16·7	45·2	40·6	35·5
Carcass, ...	59·3	59·2	82·6	53·4	58·7	64·1
Loss by evaporation, &c., ...	1·8	0·5	0·7	1·4	0·7	0·4
Total, ...	100·0	100·0	100·0	100·0	100·0	100·0

It is seen that whilst 100 lbs. live weight of the ox comprises about 11⅗ lbs. of stomach and contents, that of the sheep contains only 7½, and that of the pig only 1⅓ lbs. Of intestines and contents, on the other hand, the ox contains only 2¾, the sheep 3⅗, and the pig 6¼ per cent. Again, of stomachs and intestines (and their respective contents), taken together, the ox contains about 14⅓, sheep about 11, and pigs 7½ per cent. Thus, of the receptacles and first laboratories of the food, the oxen contain by far the largest, and pigs by far the smallest proportion, which would appear to indicate a great difference in the requirement for bulk of food, such, indeed, as we know in reality exists. Oxen require a larger proportion of woody fibre in their food than sheep, and sheep much more than pigs. On the other hand, the food of the pig contains much more starch, or allied digestible matter, than that of the sheep, and

that of sheep more than that of oxen, reckoned in relation to the weight of the animal; and it is known that starch undergoes its primary change (into sugar) almost throughout the length of the intestinal canal. Accordingly, we observe that the pig has a larger proportion of intestines than the sheep, and the sheep more than the ox.

Of the further elaborating, or what may be called the skilled labour organs of the body, and their fluids—the heart, liver, lungs, blood, &c.—the proportion is seen to be nearly the same in the three descriptions of animal.

The proportion of internal or loose fat is greater in the sheep than in the oxen; but it should be observed that a large proportion of the sheep contributing to the average result given in the table were in a more advanced state of fatness than the oxen. The comparatively small proportion of internal fat in the pig is accounted for by the peculiarities of the animal. The proportion of its internal organs is comparatively small, and its speciality is to lay on fat in a greater proportion outside the frame.

The second portion of the table shows the varying proportion of the different parts in one and the same description of animal, according to its degree of maturity. The animals selected for illustration of this point are sheep. Records not given in the table show that, as the animals grew and fattened, the actual amount, per head, of stomachs and contents increased considerably; that the intestines and contents did so in a much less degree; that the internal loose fat was more than trebled; and that the other internal parts, and their fluids, collectively, increased in nearly the same proportion as the stomachs and contents. The general result was, that the total offal parts increased in actual amount from the store to the very fat condition in the proportion of about 1 to 1⅘; but the total carcass parts augmented from 1 to nearly 2⅓—much more, therefore, than the total offal parts.

Turning now to the figures in the table, it is seen that the per cent., or proportion in 100 parts, of all the internal organs and parts, excepting the loose fat, diminished very considerably as the animals matured and fattened. Whilst the total offal parts diminished from 45·2 in the store to 40·6 in the fat, and to 35·5 per cent. in the very fat condition, the carcass parts increased from 53·4 in the store, to 58·7 in the fat, and to 64·1 per cent. in the very fat condition. That is to say, the so-called offal parts, which are chiefly composed of the organs of reception, elaboration, and transmission of the food constituents, increase in very much less proportion than those parts which it is the object of the feeder should be produced from the food consumed.

Relation of the Increase, Manure, and Loss by Respiration, to the Food consumed by different Animals.

We now come to the question of the description and amount of food consumed by the different animals to produce a given amount of increase, and to the collateral questions of the relation of the constituents in the increase and in the manure to those in the food consumed.

Table III. shows the amounts of certain foods assumed to be required for the production of 100 lbs. of increase in live weight—of oxen, sheep, and pigs, respectively. The amounts will, of course, vary, according to the quality of the animal, the stage of its development, the external conditions to which it is subjected, the description and quality of the food, and so on; but the quantities assumed are approximately those which will be required, taking the average of large numbers of animals over the whole period of fattening, and supposing foods of the descriptions indicated, and of good quality, are employed, and that other conditions are moderately favourable.

TABLE III.—*Food, Increase, Manure, &c., of Fattening Animals.*

OXEN.

	250 lbs. Oil-cake, 600 lbs. Clover Chaff, 3500 lbs. Swedes, produce 100 lbs. Increase, and supply—				100 Total Dry Substance of Food supply—			Amount of each constituent stored up, for 100 of it consumed.
	In Food.	In 100 lbs. Increase.	In Manure.	In Respiration, &c.	In Increase.	In Manure.	In Respiration, &c.	
	lbs.	lbs.	lbs.	lbs.				
Nitrogenous substance, . .	218	9·0	323·0	636	0·8	29·1	57·3	4.1
Non-nitrogenous substance,	808	58·0			5·2			7.2
Mineral matter, ...	83	1·6	81·4	—	0·2	7·4	—	1.9
Total dry substance, .	1109	68·6	404·4	636	6·2	36·5	57·3	

SHEEP.

	250 lbs. Oil-cake, 300 lbs. Clover Chaff, 4000 lbs. Swedes, produce 100 lbs. Increase, and supply—				100 Total Dry Substance of Food supply—			Amount of each constituent stored up, for 100 of it consumed.
	In Food.	In 100 lbs. Increase.	In Manure.	In Respiration, &c.	In Increase.	In Manure.	In Respiration, &c.	
	lbs.	lbs.	lbs.	lbs.				
Nitrogenous substance, . .	177	7·5	229	548·5	0·8	25·1	60·1	4·2
Non-nitrogenous substance,	671	63·0			7·0			9·4
Mineral matter, ...	64	2·0	62	—	0·2	6·8	—	3·1
Total dry substance, .	912	72·5	291	548·5	8·0	31·9	60·1	

PIGS.

	500 lbs. Barley Meal produce 100 lbs. Increase, and supply—				100 Total Dry Substance of Food supply—			Amount of each constituent stored up, for 100 of it consumed.
	In Food.	In 100 lbs. Increase.	In Manure.	In Respiration, &c.	In Increase.	In Manure.	In Respiration, &c.	
	lbs.	lbs.	lbs.	lbs.				
Nitrogenous substance, .	52	7·0	59·8	276·2	1·7	14·3	65·7	13·5
Non-nitrogenous substance,	357	66·0			15·7			18·5
Mineral matter, ...	11	0·8	10·2	—	0·2	2·4	—	7·3
Total dry substance, .	420	73·8	70·0	276·2	17·6	16·7	65 7	

The quantities of the different foods recorded in the table have been adopted after a very careful consideration of the results of numerous experiments on feeding on the large scale; and after the illustrations which have been given of the different proportions of the organs in the different descriptions of animal, it will be seen how consistent are the variations in the quantity and quality of the food recorded as required by the different animals. Thus, to produce the same amount of increase, oxen consume a much larger proportion of hay, containing so much indigestible matter, than sheep; whilst pigs are fattened on a diet as concentrated and containing as little indigestible substance as corn alone. The actual amounts of food assumed to be required for the production of 100 lbs. increase in live weight are—for oxen, 250 lbs. of oil-cake, 600 lbs. of hay-chaff, and 3500 lbs. of Swedes; for sheep, 250 lbs. of oil-cake, 300 lbs. of hay-chaff, and 4000 lbs. of Swedes; and for pigs, 500 lbs. of barley meal.

It will be remembered that, when speaking of the composition of the animals themselves, their constituents were grouped under the heads of nitrogenous substance, non-nitrogenous substance, mineral matter, and total dry substance, and the same classification is, for convenience of comparison, adopted in reference to the composition of the food, increase, and manure, of the different animals as recorded in Table III. As the food of the pig is the most simple, I will direct your attention to the figures relating to it in the first place. These will be found in the lowest division of the table.

The 500 lbs. of barley meal consumed in increasing the weight of the pig from 100 to 200 lbs. contained 420 lbs. of dry substance, and the 100 lbs. increase in live weight produced by it not quite 74 lbs.; about 70 lbs. remain in the manure, and 276 out of the 420 lbs. consumed were expended in respiration, and other exhalations from the body. Nearly two-thirds of the whole dry substance consumed have, therefore, been expended in keeping in working order the living meat and manure-making machine.

Looking to the column showing the composition of the 100 lbs. of increase, it is seen that it contains only 7 lbs. of nitrogenous substance, and 66 lbs., or more than 9 times as much non-nitrogenous substance or fat, whilst the mineral matter does not amount to 1 per cent. The general result is, then, that nearly two-thirds of the fattening increase in live weight were pure fat itself, and only about one-fourteenth of it nitrogenous substance or lean meat.

But to produce the 7 lbs. of nitrogenous substance in increase, 52 lbs. were consumed in food; by far the greater part of the remainder being found in the manure. To produce the 66 lbs. of fat, 357 lbs. of non-nitrogenous substance were consumed; but as it existed in the food almost entirely in the form of starch, and as it requires about 2½ parts of starch to form 1 of fat, it may be said that at least 165 lbs. of the non-nitrogenous substance consumed contributed pretty directly to the formation of the 66 lbs. of fat. Lastly in reference to the increase: of the 11 lbs.

of mineral matter consumed, only about ¾ lb. were stored up in the increase of the animal.

It is observed, then, that a comparatively small proportion of either the nitrogenous substance or the mineral matter of the food, is retained in the increase; the manure, on the other hand, retains a very large proportion of the former, and nearly the whole of the latter.

Of 100 parts of gross dry substance consumed, 1·7 parts of nitrogenous substance, 15·7 of fat, and 0·2 of mineral matter—in all 17·6 parts—are stored up in the increase; 14·3 parts, consisting of highly nitrogenous organic matter, and 2·4 parts of mineral matter, making a total of 16·7 parts, are retained in the manure; and 65·7 parts, consisting chiefly of carbon, hydrogen, and oxygen, are lost by respiration, &c. Or, if we reckon the proportion of each class of constituents consumed which is stored up in the increase, the last column of the table shows that of 100 of nitrogenous substance consumed, 13·5 parts; of 100 non-nitrogenous substance consumed, 18·5 parts; and of 100 mineral matter consumed, 7·3 parts are retained in the increase.

It will not be necessary to follow so closely the figures in the table relating to the sheep and oxen. It will suffice to direct attention to the chief differences of result obtained with the three descriptions of animal.

Whilst the pig required only 420 lbs., the sheep required 912 lbs., and the oxen 1109 lbs. of dry substance in food to produce 100 lbs. increase in live weight. In other words, the sheep consumed more than twice as much, and the oxen more than two and a half times as much, to produce a given amount of increase, as the pig. But the food of the pig was of a much higher character than that of the other animals. Whilst it consisted entirely of highly elaborated grain, closely resembling human food, the food of the other animals contained a large amount both of woody fibre and of crude succulent roots; the dietary of the ox containing the largest proportion of hay, with its high percentage of indigestible woody matter.

Turning to the columns giving the composition of 100 parts of the increase, they show that whilst that of the pig contained 73·8 parts of dry substance, that of the sheep contained rather less, and that of the oxen rather less still. The proportion of fat also was greater in the increase of the pig than in that of sheep, and greater in that of the sheep than in that of the oxen. The contrary was, however, the case with the proportion of nitrogenous substance, which was the greatest (9 per cent.) in the increase of the oxen, less (7·5 per cent.) in that of sheep, and less still (7 per cent.) in that of pigs. It will be observed, too, that the percentage of mineral matter in the increase of the ox and sheep is considerably higher than in that of the pig; and it is even rather higher in the case of sheep than oxen. Independently of any essential differences of structure in the different animals, this result is partly due to the fact that sheep and oxen, especially sheep, develope bony structure during the fattening process more than pigs. It is true that both

sheep and pigs are, compared with oxen, fattened at an earlier stage of their development; but not only is the pig more naturally disposed to fatten instead of grow in frame very early in his career, if only liberally supplied with proper food, but the practice of feeders, to meet the demands of the market, is to encourage growth as well as fattening much more in the case of sheep than of pigs.

Comparing the constituents stored up in increase for a given amount of dry substance of food consumed in each case, the table shows that for 100 gross dry substance of food, the oxen and sheep stored up less than 1 per cent., and the pigs more than twice as much of nitrogenous substance; that of fat the oxen stored up only 5·2, the sheep 7, and the pigs 15·7 parts.

Or, looking at the subject from another point of view, the last column of the table shows that for 100 nitrogenous substance of food consumed, the oxen and sheep stored up little more than 4, but the pig about 13·5 parts; that for 100 non-nitrogenous substance in food, the oxen yielded 7·2, the sheep 9·4, and the pigs 18·5 parts of fat in increase; and that for 100 mineral matter consumed, the oxen stored up 1·9, the sheep 3·1, and the pigs 7·3 parts.

That a very much larger proportion of the constituents of the food of the pig than of that of oxen and sheep should be stored up as increase is, however, only what we should expect, when we consider that the former consists of matured grain, and the latter chiefly of comparatively immatured vegetable produce, containing a large proportion of indigestible and woody matter, and also a larger amount of nitrogenous and mineral matter in proportion to its digestible and available non-nitrogenous constituents.

But whilst the pig, with his much higher character of food, gave so much more increase than the sheep for a given amount consumed, and the sheep more than the ox, the ox returned as manure 36·5 per cent. of the dry substance he consumed, the sheep not quite 32, and the pig only 16·7 per cent. The proportion of the consumed matter that was lost by respiration was, on the other hand, rather the lowest with the ox, namely, 57·3 per cent.; whilst with the sheep it was 60·1, and with the pig it was 65·7 per cent. Or, reckoned in proportion to a given amount of increase produced, the oxen gave, for 100 lbs. of increase in live weight, 404 lbs., the sheep 291, and the pigs only 70 lbs. of dry substance in manure; and for the same amount of increase, the oxen lost of dry substance, by respiration, &c., 636 lbs., the sheep 548·5 lbs., and the pigs 276·2 lbs.

There is another point from which it is desirable to view the difference of the result obtained with the different descriptions of animal. This is illustrated by the figures given in Table IV., which shows for oxen, sheep, and pigs, respectively, the amounts of increase yielded, and of dry substance consumed in food, voided as manure, and lost by respiration, per 100 lbs. live weight per week.

TABLE IV.—*Amount of Increase yielded, and of Dry Substance consumed in Food, recovered as Manure, and lost by Respiration, &c., per* 100 *lbs. live weight, per week.*

	Per 100 lbs. live Weight, per Week.			
	Increase yielded.	Dry Substance.		
		Consumed in Food.	Recovered as Manure.	Lost by Respiration, &c.
	lbs.	lbs.	lbs.	lbs.
Oxen, ...	·13	12·5	4·56	7·16
Sheep, ...	1·76	16·0	5·10	9·62
Pigs, ...	1·43	27·0	4·51	17·74
	6			

The first column of this table shows that whilst the pig increases from 6 to 6½ per cent. of its weight per week, the sheep increases only 1¾, and the ox little more than 1 per cent. No wonder, then (to say nothing of the difference in the character of the food), that the oxen and sheep, requiring so much longer time to add a given proportion to the weight of their bodies, should consume so much more food, void so much more as manure, and expend so much more in respiration, for a given amount of increase produced, as we have seen they do.

The other columns of the table show, however, that neither the amount of dry substance of food consumed, nor the amount lost by respiration, by a given weight of animal within a given time, is in excess with the pig in anything like the proportion that its increase exceeds that of the other animals. In other words, the much higher character of the food of the pig shows itself in the much greater rapidity, and the much greater proportion of its conversion into meat—the most valuable product of the feeding operation.

Lastly in regard to the results in this table, it is remarkable that, whilst, for a given weight of the body within a given time, the amounts of increase yielded, and of dry substance consumed in food, and lost by respiration, are so very different for the different animals, the amounts of dry substance voided in excrements are almost identical. I shall show further on that the limit of consumption is much regulated by the amount of non-nitrogenous substance contained in the food; and hence it would appear that the respiratory function had much to do with determining the amount of food consumed. It would also seem, from the equality of amount of dry substance voided by a given live weight of the different descriptions of animal within a given time, that the limit of consumption had also some connexion with the amount of transformed and effete matter that the system could pass; and hence that the surplus available for increase was fixed by the necessary proportion of digestible and assimilable to effete matter in the appropriate food of the respective animals.

To sum up the points thus far illustrated, it may be said—

1. That during the fattening process the proportion, in a given weight of the body, of water, mineral matter, and nitrogenous compounds decreases, whilst that of the fat very considerably increases.

2. That the carcass parts, or saleable meat, increase more rapidly than the internal parts or offal.

3. That the amount of dry substance of food required to produce a given weight of increase is larger with the ox than with the sheep, and larger with the sheep than with the pig.

4. That the dry substance of the food of the ox contains a larger proportion of indigestible matter than that of sheep, and that of sheep more than that of pigs.

5. That oxen require from 5 to 6, and sheep from 3 to 4 times as much time to add a given proportion to the weight of their bodies as pigs.

6. That the greater portion of the nitrogenous and mineral matters of the food is recovered in the manure; and that the greater part of the non-nitrogenous substance is lost by respiration and other exhalations—a much smaller proportion being retained in the increase, or voided in the manure.

7. That for a given amount of increase produced, oxen void considerably more substance as manure, and expend more in respiration, &c., than sheep, and sheep very much more than pigs.

8. That for a given weight of dry substance consumed, oxen void more as manure than sheep, and sheep much more than pigs; but oxen respire rather less than sheep, and sheep rather less than pigs.

9. That in proportion to a given weight of animal, within a given time, oxen both consume and respire less dry substance of food than sheep, and sheep very much less than pigs; but they void almost identical amounts of dry substance as manure.

Comparative Feeding Value of different Foods, according to their Composition.

Thus far I have endeavoured to indicate the characteristic points of distinction between the food of the ox, the sheep, and the pig, and to show in what respects its constituents are differently disposed of by the different animals; and for the purposes of my illustration, I have supposed the animals to be fed on such foods as are recognised as appropriate to them, and in such proportion and amount as experience justifies. I now propose to say a few words on the relative feeding properties of different foods, according to their composition.

Leaving out of view, just now, the incombustible or mineral constituents, it will be convenient, as before, to consider the other constituents of food to be grouped under the heads of nitrogenous and non-nitrogenous substances.

Among the nitrogenous substances, the most important of those which enter into our stock foods are albumen, casein, legumin, and gluten; and chemists and physiologists are accustomed to speak of these—the nitrogenous compounds—as the flesh-forming substances.

The non-nitrogenous constituents of our stock foods are starch, sugar, gum, pectin, oil, and cellulose, or woody fibre in different conditions of digestibility or induration. The non-nitrogenous compounds are spoken of as the respiratory or heat-producing, and fat-forming substances.

Now, writers on agricultural chemistry and physiology have generally assumed that it is chiefly the proportion of the nitrogenous or so-called flesh-forming substances contained in them, which determines the comparative value, for feeding purposes, of different foods.

The coloured diagram before you will enable you to judge whether or not this supposition is justified by the practical experience of feeding. This diagram has been constructed by the animals themselves. They know nothing about nitrogenous or non-nitrogenous constituents, digestible or indigestible cellulose, and so on; but they are gifted with an unerring instinct, which enables them not only to distinguish between substances which are and are not food, but also to select from a variety of food stuffs those which are most suitable for the requirements of the system, and so to indicate to us the proper amounts and proportions of the different constituents.

In the experiments to which the diagram refers, as well as in many others, the plan has been to select foods containing very different proportions of nitrogenous and non-nitrogenous compounds; in fact, some containing two or three times as much nitrogen as others. We have then given to one set of animals a small fixed amount daily, of food containing a low percentage of nitrogen, and allowed them to take as much as they chose of another food, different in composition in this respect. To another set we have given a limited amount of food, rich in nitrogenous compounds, and allowed the animals to take, *ad libitum*, of a different description of food, and so on. In this way they have been enabled to fix for themselves the limit of their consumption of nitrogenous and non-nitrogenous constituents, respectively, according to their wants.

The diagram shows the results of such experiments with pigs; and the foods employed were Indian corn meal, barley meal, bean meal, lentil meal, bran, and dried cod-fish, used alone, or in combination, as the case might be. Black being taken to represent nitrogenous substance, red non-nitrogenous substance, and green total dry organic matter (nitrogenous and non-nitrogenous together), the diagram is constructed as follows:—The smallest quantity of nitrogenous, or non-nitrogenous, or total organic matter consumed in any one experiment is reckoned as 100; and the several lines above the base line, which is marked 100, indicate larger amounts, corresponding to the figures given at the side of the diagram.

The upper portion shows the relative amounts of each constituent consumed in each experiment per 100 lbs. live weight per week; that is to say, by a given weight of animal within a given time. A glance shows you that the height to which the colours representing the non-nitrogenous, or the total organic substance reach is very much more uni-

form than that indicating the consumption of nitrogenous substance. In fact, it is perfectly clear that the animals were guided in the amount of food which they consumed by the amount of non-nitrogenous, and not by that of the nitrogenous constituents which it supplied.

But, according to current theories, the amount of nitrogenous substance ought at least to determine the amount of increase produced. The lower portion of the diagram shows what the animals have to say on this point. The arrangement is the same as before; but the results show, not how much of each class of constituents was consumed by a given weight of animal within a given time, but how much was consumed to produce a given weight (100 lbs.) of increase.

Here again we see that the amount of either non-nitrogenous or total organic substance consumed varied comparatively little, whilst that of the nitrogenous substance consumed for the production of a given amount of increase varied from 100 to over 300 parts.

It is obvious, therefore, that both the amount of food consumed by a given weight of animal within a given time, and that required to produce a given weight of increase, were determined by the amount of available non-nitrogenous substance which the food supplied. The quantities required would, doubtless, have varied within even narrower limits, had all the foods contained equal proportions of indigestible woody matter.

It may be observed that it is doubtful whether pigs are able to digest cellulose, or woody fibre, at all; but there is no doubt, as the investigations of ourselves and others on the point sufficiently prove, that oxen and sheep are able to digest a considerable portion of such matter, when it is not in too indurated a condition.

It will, of course, be understood, that a certain amount and proportion of nitrogenous substance is essential in the food of animals; and if I were asked to state in general terms what was the approximate proportion of the nitrogenous to the digestible non-nitrogenous substances, below which they should not exist in the food of our stock, I should say (though with reservations), about such as we find them in the cereal grains; and since few of our stock foods are below, and many above, this in their proportion of nitrogenous substance, it results that we are more likely to give an excess than a deficiency of such constituents, so far as the requirements of the animal are concerned. The value of the manure depends, however, very much on the amount of the nitrogen which the food contains; but to this point I shall recur after directing attention to a few more points in connexion with the comparative values of different foods as such.

Some years ago we published the results of some experiments on the equivalency of starch and sugar in food, pigs being the subject of the trial. Several lots having each a fixed and limited quantity of lentil-meal and bran allowed, one was permitted to take as much starch, another as much sugar, and another as much of the mixture of the two as they chose; whilst in another experiment the animals were allowed to select at discretion from lentils, bran, sugar, or starch, each placed separately within their reach. The result was, that sugar and starch were found to have, weight for weight, practically the same value as constituents of food.

These results would, *à priori*, lead to an answer in the negative to the much agitated question, whether there is any advantage in malting barley for feeding purposes. The chief effect of the malting process is to convert starch into sugar– not, it is true, sugar of exactly the same description as that used in our experiments; but there is good reason for supposing that malt sugar would have a lower value than cane sugar as a food constituent; and direct experiments, made many years ago at Rothamsted, have shown that a given amount of malt, mixed with other food, gave less rather than more increase than the amount of barley from which it was produced. It is obvious, too, that as the conversion of barley into malt is a manufacturing process, attended with considerable cost, as well as actual loss of substance, the remission of the duty on malt employed for feeding purposes would not be likely to be of benefit to the farmer, unless either a given amount of malt sugar proved to be of considerably higher feeding value than the starch from which it was produced, or the other constituents were rendered more digestible and assimilable by the process.

This leads me, before leaving the subject of foods, to make a few remarks on some other manufactured foods for stock. Many complaints are made, and justly made, of the adulteration of oil-cakes; and it is sometimes asserted that cheaper and better foods than the average of cakes now in use could be manufactured with advantage both to the maker and to the feeder. Linseed and other cakes are themselves, in one sense, manufactured foods. But the object of the manufacturer is not the production of cake, but of oil. If the farmer did not use the cake at all, it would still be made, and the oil would be sold for a higher price. As it is, the manufacturer makes the cake as a bye-product, and the price he gets for it enables him to sell his oil so much the cheaper.

But if manufactories were set up for the special purpose of preparing foods for stock, the whole cost of the undertakings must be charged upon the food. Lentils, beans, peas, Indian meal, barley meal, linseed, and other good staple foods must be used; and although it might be possible so to combine foods together that a given weight of the mixture would possess a somewhat higher feeding value than the component parts used singly, there is every reason to suppose that the increased cost would more than counterbalance any slight benefit that could be derived in that way. Nor do I anticipate that the progress of science will aid us much in this direction. Condimental foods have been tried, and found wanting; and I have little doubt that a similar result will attend the manufacture and use of simpler food mixtures. Our hopes as feeders must be in increased and cheap supplies of ordinary cattle foods of a good quality, rather than in submitting those we have to costly processes of manufacture.

The results arrived at in regard to this portion of the subject may be briefly summed up as follows:—

1. The comparative feeding value of our current stock foods depends

more upon the proportion of the digestible non-nitrogenous substances they contain than upon their richness in nitrogenous compounds; but the richer the food in nitrogen, the more valuable will be the manure.

2. Of the non-nitrogenous constituents of food, starch and cane sugar have, weight for weight, nearly equal feeding values; malt sugar has probably rather a lower value than either cane sugar or starch; digestible cellulose, in moderate proportion, has, for ruminant animals, probably nearly the same value as starch; and fat or oil have probably about two and a half times the value of starch for the purposes of respiration, or the storing up of fat in the body.

3. Some advantage results, in a feeding point of view, from the judicious mixture of a variety of ordinary stock foods; but the benefit to be derived in this way is not such as to compensate for the extra cost of a special manufacturing process to attain it.

Connexion between the Value of the Manure and the Composition of the Food consumed.

The next and last branch of the subject relates to the comparative value of the different constituents in the liquid and solid voidings of the animals, and to the connexion between the value of the manure and the composition of the food from which it is produced.

I have already pointed out that the greater portion of the carbon, hydrogen, and oxygen of the food either passes into the increase or off in respiration, and that comparatively little of any of them is recovered in manure. By far the larger portion of the nitrogen, and nearly the whole of the mineral matter consumed are, however, so recovered.

To show the economic connexion between the feeding of stock for the production of meat and manure, and the growth of corn, I propose to adduce a few results obtained in experiments on the growth of wheat by different manures. In the experiments in question, wheat has been grown for twenty successive seasons on the same land.

In Table V. are given the average annual produce of corn and straw, and the estimated yield of carbon, per acre, over the last twelve years, respectively without manure, with mineral manure alone, with mineral and nitrogenous manure (ammonia salts), and with farm-yard manure.

Table V.—*Average Annual Produce of Wheat, and estimated Yield of Carbon, per Acre, over 12 Years.*

Manures per Acre per Annum.	Average Annual Produce per Acre.			
	Dressed Corn.	Total Corn.	Straw.	Carbon.
	Bushels.	lbs.	lbs.	lbs.
Unmanured, ...	15½	964	1662	1062
Mineral manure alone, . .	18½	1157	1897	1234
Mineral manure and 400lbs. ammonia salts, ...	36½	2275	4212	2625
14 tons farm-yard manure, .	35½	2232	3869	2467

Where the farm-yard manure was employed, more carbon, as well as more of every other constituent, was annually applied in manure than removed in the crop. In the other cases no carbon whatever was supplied in the manure; and yet it will be observed that where the mineral manure and ammonia salts were employed (the latter containing a large amount of nitrogen), the yield of carbon was greater than where a large amount of that substance was supplied by means of farm-yard manure. This carbon must have been derived from the atmosphere. In several experiments in this field last year, from 1½ to 1¾ tons of carbon per acre were removed in the crop, without any being supplied in manure; but in these cases large quantities of nitrogen were supplied.

The quantity of carbonic acid required to yield 1½ tons of carbon to the crop is about as much as would be given off into the atmosphere in a year by twenty-two individuals of a mixed population of both sexes and all ages, and it will be seen that it is under the influence of ammoniacal or nitrogenous manure that this large amount of carbon has been fixed in the plant from the carbonic acid of the atmosphere.

The results given in Table III. showed how small was the proportion of the nitrogen consumed by an animal in its food that was stored up in its increase, and sent to market as meat. If there were none of the nitrogen of the food lost in the various exhalations from the body the whole of that not stored up in increase would be found in the manure. But the investigations of ourselves and others show that a certain portion of the nitrogen is so lost. Our own experiments to determine the limit of this loss, and the circumstances under which it is greater or less, were commenced as far back as 1847, and have been resumed occasionally from that time to the present; and during the last few years we have collected a great deal of experimental data on the subject; but as the whole of the analytical work is not yet concluded, I do not feel that I am in a position to give any numerical statement of the results obtained. It may, however, be stated as beyond doubt, that by far the larger portion of the nitrogen consumed in food is rejected by the animals in their liquid and solid voidings; and that the higher the proportion of nitrogen in the food, the richer will be the excrements in that important constituent of manures.

Some years ago I published a Table, showing the estimated value of the manure obtained from the consumption of one ton of different articles of food used in ordinary farm practice. The valuation was founded upon a knowledge of the average composition of the different descriptions of food, and upon information, arrived at in the course of the experiments just referred to, as to the probable average amount of the constituents of food valuable for manure which will be obtained in the solid and liquid excrements of the animals.

Stating the results of these valuations in very general terms, it may be said that the estimated value of the manure from 1 ton of oil-cake was considerably more than that from the same quantity of linseed, lentils, tares, beans, or peas; from two to three times as much as that from 1 ton of oats, wheat, Indian corn, barley, or hay; from seven to ten

times as much as from the same weight of oat, wheat, or barley straw; and about twenty times as much as from 1 ton of roots.

It is obvious, therefore, that in the selection of purchased foods for stock, it is very important to consider their manuring as well as their feeding value. One illustration on this point will suffice. A ton of locust beans will certainly not yield nitrogen in the manure of the animals consuming it equal to more than, if to as much as, ¼ cwt., or 28 lbs., of ammonia; but a ton of rape-cake will yield 1 cwt., or four times as much. If, therefore, we take the ammonia in the manure at 7*d*. per lb., the amount of it obtained from the consumption of a ton of locust beans will be worth only 16*s*. 4*d*.; whilst that from the ton of rape-cake will be £3 5*s*. 4*d*.

There is, in fact, far greater difference in the manuring than in the feeding value of most of the ordinary stock foods in the market.

In illustrating the comparative value of the manure obtained from different foods, by reference merely to the amounts of nitrogen or ammonia-yielding matter which they supply, it will not be understood that I in any way ignore or underrate the value of the mineral constituents associated with the nitrogenous matter in the excrements. But, inasmuch as the amount of mineral constituents voided is generally in excess of that required for the due effect as manure of the nitrogen with which they are accompanied, it results that the amount of the nitrogen or ammonia-yielding matter is practically the best index to the value of the manure.

Appropriateness of Animal Food in the Diet of Man.

It will be obvious that the importance of the subject which I have brought before you this evening rests upon the assumption that animal food is an important element in the diet of man. There are, indeed, some who maintain that a purely vegetable diet would be more suitable and natural than the mixed vegetable and animal one so generally preferred. If their view were adopted, we need no longer trouble ourselves about the connexion between the food, the increase, and the manure of fattening oxen, sheep, and pigs. There are, however, various circumstances, economical and physiological, pointing to the appropriateness of admitting a certain proportion of animal food into the diet of man. To one or two of these I will briefly refer.

Walking is for man undoubtedly a very natural means of progression. Still, it is often very advantageous to ride, and so to employ the legs of a quadruped instead of our own. In eating meat we may be said to employ the stomachs of other animals to do that which we could not so well do with our own. As a few ounces of gold are separated from many tons of rock by the combined aid of mechanical and chemical processes, so the animals feeding upon crude, and often to us indigestible, vegetable matter, eliminate from it, and store up in their bodies some of its constituents in a form at once much more concentrated than that in which they consumed them, and much more easily appropriated by the human economy. A given amount of nitrogenous compounds in the form of meat is undoubtedly more easily digested and assimilated by man than if the same amount were supplied in the form of beans. Then, again, the animals convert starch, sugar, &c. (and probably some of them cellulose, which we could not digest at all), into fat, which has twice and a half the respiratory and fat-storing capacity of the substances from which they produce it. It is, doubtless, true that man can produce fat, and keep up his respiratory function from starch and sugar; but it can hardly be doubted that there is some economy to his system in having a portion of fat supplied to him ready made.

Apart from the strong testimony of common experience on the subject, there is evidence in the comparative structure of man that he is adapted for a concentrated form of food. One illustration, in passing, may be adduced on this point. Table VI. shows the proportion of the stomach, by weight, in a given live weight of oxen, sheep, pigs, and man:—

TABLE VI.—*Proportion of Stomach in different Animals.*

Stomach in 100 lbs. live weight:—

Oxen, ...	51 ounces.	Sheep, ...	39 ounces.
Pigs, ...	14 „	Man, ...	6 „

Relative weight does not, of course, necessarily represent with numerical exactness relative capacity or size. But there is little doubt that there is a gradation in the capacity of the stomach relatively to a given weight of the body in the animals enumerated, in the order, and to a great extent in the degree indicated by the figures given in the Table. Admitting this to be the case, we have seen that the sheep, with its less proportion of stomach than the ox, takes a somewhat more concentrated food; and that the pig, with its much less proportion of stomach than the sheep, requires a much more concentrated food than the latter. May we not conclude that man in his turn, with his less proportion of stomach than the pig, will also appropriately take a more concentrated food than his useful friend?

The food of man is, indeed, very closely allied, in a chemical point of view, to that of the pig. The staple of the food of both the fattening pig, and man, is cereal grain. The pig, it is true, consumes the husk as well as the farinal portion, whilst man does not; but we know that this proportion of indigestible woody matter is very nearly the limit of that which is appropriate for the fattening pig, and that on the addition of a small quantity of bran the proportion of increase diminishes, and that of the dry substance of the food voided as excrement increases. The only other essential difference is, that the pig takes, as a rule, the whole of his nitrogenous compounds in the form of vegetable products, and a much larger proportion of starch, and other non-nitrogenous compounds, more bulky in relation to their respiratory and fat-forming capacity than fat itself. Not, indeed, that the pig is at all unapt or unwilling to adopt even still more closely the diet of man; for he will take animal flesh and fat when he can get them, and, what is more, he likes them better cooked than raw.

Were it not, then, that man separates the husk from the flour, and that he gets lower animals to eliminate in an easily digestible form a portion of his nitrogenous aliment, from foods which he could not himself readily digest, and that he gets them also to provide him with a portion of his respiratory and fat-storing food in the concentrated form of fat itself, we could hardly account for the less proportion to a given weight of the body of the stomach—the receptacle and first laboratory of the food—in his case than in that of the pig. We know, indeed, that in the cases where man is reduced to depend for nearly the whole of the non-nitrogenous constituents of his food upon starch, in the form of potatoes or rice, there is a disposition to an enlargement of the abdominal organs, and to a diminution in physical and mental energy.

To conclude on this point, there can be no doubt whatever that the food of the labouring man is improved when he can add to his bread a portion of fat bacon, or butter, or fat in some other form, and it is better still if he can substitute or supplement a little butcher's meat. Indeed, that which common experience recognises as high quality of diet is, within certain limits, high proportion of animal to vegetable food, and with it high proportion of fat to starch and other non-nitrogenous compounds.

But not only do the animals which we fatten for our own food convert vegetable produce which we either could not digest at all, or could do much less easily than they, into concentrated and easily digestible and assimilable material for our use, but in doing this they supply carbonic acid to the atmosphere, and return the most important manurial constituents of their food in their excrements, thus providing, to both the soil and the atmosphere, from crude vegetable products, that which is necessary for the luxuriant growth of cereal grain, and other vegetable produce suited for the direct use as food for man.

Were it not for such compensations, by the increase of man and other animals upon the surface of the earth (if it could take place at all), by the enormous quantities of carbonic acid evolved into the atmosphere from the combustion of coal and from other sources, and by the gradual destruction of forests, which are the chief natural agents for restoring the balance, the purity of the atmosphere would become affected. But the grasses, which supply so large a proportion of the food of beasts, and the cereals and the other plants of the same great family, which supply food to man in almost every climate, serve to re-use the carbon given into the atmosphere in the form of carbonic acid. It may seem at first sight strange that the humble grasses, and the corn crops, reaching only a few feet from the surface of the ground, should be able to take up more carbonic acid, and evolve more oxygen, over an acre of land than an acre covered with forest trees. Still, there can be little doubt that more carbon is fixed in an acre of luxuriant wheat than over the same area of woodland; and there can be as little that an acre of sugar cane would fix more than an equal area of the most luxuriant tropical forest.

Conclusion.

With a few general remarks of a practical nature, I will conclude my discourse. The great change which has taken place in the practice of feeding stock in modern times has consisted in bringing the animals much earlier to maturity, by means of careful breeding, and more liberal feeding. Scales and weights were seldom used in agricultural experiments until comparatively recently; but there are some few records of the results of feeding as practised at the latter end of the last century, which will serve us in instituting a comparison between the results then obtained and those which are possible, or even common, at the present day.

In 1794 the Duke of Bedford made some experiments to determine the comparative feeding qualities of South Down, Leicester, Worcester, and Wiltshire sheep. Twenty of each were selected and weighed on November 19, 1794. To each lot were allotted 16 acres of pasture, and in the winter some turnips were thrown upon the pasture, and a small quantity of hay was also provided. On February 16, 1796, after a period of sixty-five weeks of feeding, the experiment was concluded, and the sheep sent to market.

Over the whole period the sheep gave an average increase of between 40 and 50 lbs. per head; and as their original weight was nearly 100 lbs. per head, they increased nearly 50 per cent. from the store or lean to the fat condition, which is the same proportion as that assumed in the illustrations to which Table III. refers.

Some years ago, I tried a set of experiments upon the comparative fattening qualities of South Downs, Hampshire Downs, Cotswolds, Leicesters, and cross-bred wethers, and cross-bred ewes, each lot consisting of between 40 and 50 sheep. They were put up in November, when their weights were very nearly the same as those of the Duke of Bedford's sheep; and when fat, they had increased in about the same degree, namely, to an average of about 150 lbs. each. The Duke of Bedford's sheep were about 65 weeks in adding 50 lbs. to their weight, and mine in some cases 20, and in others a little more, or about one-third the time. It is somewhat singular that in May—the period at which my sheep were consumed as mutton—the Duke of Bedford's were weighed for the first time since the commencement of the experiment, and were found to have increased only about 6 lbs. per head.

The difference of result in these two cases was almost entirely due to the difference in the mode of feeding. Formerly, sheep received perhaps a few turnips on their pasture, and but little dry food, and that not of high feeding quality; and the consequence was, that during the colder months of the year they either lost weight or increased but little. Now they have a liberal allowance of good food, and are frequently protected from the inclemency of the weather. In my own experiments, just referred to, the sheep were allowed from ¾ lb. to 1 lb. of oil-cake per head per day, according to their weight, about the same amount of clover chaff, and as many Swedes as they chose to eat, and they gave an average increase of nearly 2 per cent. upon their weight per week.

There is no doubt that in rapidly fattening stock at an early age, quality of meat is to some extent sacrificed to quantity. But it is only by means of the modern system of liberal feeding and early maturity that meat can be brought within the reach of the masses of the population. The farmer, too, must look to that system which will pay him the best; and the difference between the price which the consumer will give for a pound of four-year-old and one-year-old mutton will, only under very exceptional circumstances of locality, remunerate him for the extra cost of production.

In conclusion, I have only now to thank you for the very kind attention with which you have followed me through what I fear may be thought by many of you somewhat tedious detail. The subject of the chemistry of feeding is, however, essentially an intricate one; and I think you will have learnt from my lecture, if you did not know it before, that there still remains much to be determined by careful investigation respecting it. But if I have in any degree succeeded in indicating the proper points of view from which this, at once practical and scientific question should be studied, and in impressing upon your minds some prominent and important facts regarding it, so as to lead to improvement in practice by a better knowledge of principle, or to further inquiry, and so to an extension of our knowledge, I shall feel that the objects of my desire and endeavour in addressing you have been fully attained.

THE END.

ON POISONING BY DISEASED PORK.

BEING

AN ESSAY

ON

TRICHINOSIS,

OR

FLESH-WORM DISEASE:

ITS PREVENTION AND CURE.

BY

JULIUS ALTHAUS, M.D., M.R.C.P., LOND.,

PHYSICIAN TO THE ROYAL INFIRMARY FOR DISEASES OF THE CHEST.

"And the swine, though he divide the hoof and be cloven-footed, yet he cheweth not the cud; he is unclean to you. Of their flesh shall ye not eat, and their carcase shall ye not touch."—

LEVITICUS xi. 7—8.

LONDON:

JOHN CHURCHILL AND SONS, NEW BURLINGTON STREET.

MDCCCLXIV.

TO

PROFESSOR RICHARD OWEN, F.R.S.,

THE DISCOVERER OF TRICHINA SPIRALIS,

THESE PAGES ARE INSCRIBED

BY

THE AUTHOR.

PREFACE.

This Essay is partly reprinted from the *Medical Times and Gazette*, in the hope, that the importance of the subject of which it treats will be a sufficient excuse for its publication in a separate form. In the interval between the appearance of the former and the present paper, several new facts concerning Trichina Disease have come to light; and I have thus been able to make numerous additions, especially from Dr. Rupprecht's valuable account of the Hettstädt Epidemic, which has just been published. Although up to the present time Trichina Disease in the living subject has not been recognised in England, yet there can be no doubt, from the results obtained in the dissecting-rooms of the London and Edinburgh hospitals, that it frequently occurs here, and that a great amount of suffering may be prevented, and, perhaps, many lives saved, by attention to a few facts and simple rules which may be learnt not only by medical men, but equally well by the public. Here there is a disease which is more fatal than typhoid fever; but which may with absolute certainty be prevented, if proper precautions are taken. It is, therefore, the duty not only of the medical profession, but also of the municipal authorities, to take the subject into serious consideration.

18, Bryanston Street,
Portman Square.

ON TRICHINOSIS,

OR

FLESH-WORM DISEASE.

The danger attending the use of diseased meat, has rarely been exemplified in so striking a manner as by the discovery of Trichina Disease. Within the last few years, numerous cases of illness have occurred in various parts of Germany, which, although resembling certain complaints with which we have been long familiar, yet presented so many peculiarities, as to attract considerable attention on the part of the medical profession. In 1860, it was discovered, by the aid of the microscope, that the distemper was due to the immigration into the system of a very minute worm, which occurs chiefly in the flesh of pigs, and which has long been known to zoologists by the name of Trichina spiralis. Although the disease may seem new, there is strong reason to believe that it has always existed; but was not recognised as such by the medical profession. There are, in fact, many cases on record in medical literature, which were at the time believed to be such, of gastric, rheumatic, or typhoid fever, or in which even poisoning with criminal intent was suspected; but which we may now safely claim as instances of Trichina disease.

Two cases in point may be mentioned, one of which occurred in Germany, the other in England. In 1863, Professor Langenbeck, of Berlin, excised a tumour which had grown on the neck of a man. During the operation he noticed that the muscles which were laid bare contained a number of encysted trichinæ. The patient being questioned whether he had not at one time or another been afflicted with a remarkable illness, related the following history:—In 1845, a committee of eight gentlemen, being engaged in the inspection of schools in Saxony, dined together at an inn, and partook, amongst other dishes, of ham and sausages. They all, with the exception of one who merely drank a glass of claret, fell ill, and four died. Suspicion fell upon the meal and the host. The wine from which they had drunk was analysed; and, although no poison was found, the host continued to be suspected, and was at last obliged to emigrate.

The second case in point has been described by Mr. Henry Wood, of Bristol, in the *London Medical Gazette* for 1835. A man, aged 22, was admitted to the Bristol Infirmary *with a violent attack of acute rheumatism;* the pain and tenderness of his limbs and trunk were so great as to render him unable to support himself. He was brought into the house on the back of his father. He was a stout athletic-looking man, and was stated by his friends to have been, up to the time of his illness, very healthy and powerful. A fortnight previous to his admission, he showed signs of indisposition which were attributed to an ordinary cold; the pain in his limbs increased rapidly; he was much troubled with cough and dyspnœa, and he kept his bed six days before his admission into the hospital. He died seven days afterwards, and it was found that there were pneumonia and pericarditis; while in the muscles were seen appearances, in many respects similar to those described by Mr. Owen:—"The trichinæ were confined to the interfascicular membrane of the large muscles, and principally to those of the chest and shoulder; being most apparent in the pectoral and deltoid, less so in those of the arm, and becoming still fewer in the legs." Mr. Wood concludes his very interesting paper by stating, that he endeavoured to gain assistance from some members of the profession in making further observations at the time; but he was foiled, as it appeared to him, from the want of proper value being attached to the microscope as a means of pathological research. The symptoms described by him are those commonly observed in Trichina Disease.

Trichinæ were first noticed in England, where in 1832, Mr. Hilton, of Guy's Hospital, noticed in the pectoral muscles of a man aged 70, who had died of cancer, the cysts in which the worms are generally found enclosed, and which appear to the

FIG. 1.

naked eye as small white specks. Mr. Hilton believed these corpuscles to be dependent upon the formation of very small cysticerci.

The muscles of bodies dissected at St. Bartholomew's Hospital, had also been more than once noticed by Mr. Wormald, then Demonstrator of Anatomy at that establishment, to be beset with minute whitish specks; and this appearance having been again remarked in the body of an Italian, aged 45, by Mr. Paget, then a student of the hospital, who suspected it to be produced by minute entozoa, Mr. Owen was furnished with portions of the muscles. He discovered a nematoid worm enclosed in the cyst, and called it *Trichina spiralis*, on account of its resembling a hair in its minute filiform size and its being coiled up into spiral turns. This name has been generally accepted by

FIG. 2.

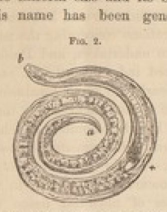


FIG. 2.—Female trichina from the muscle of a man; the cyst is removed, but the spiral turns are preserved. *a* is the head, *b* the tail. The alimentary canal begins at *a*; its structure is cellular, and it fills up the whole of the inner part of the body from *a* till †, while from † to *b* it is reduced in thickness.

zoologists, and it is only quite recently that M. Davaine, the author of a well-known treatise on entozoa, has proposed a different name for it, viz., Pseudalius Trichina. The only reason that can be given for this innovation is, that the tail of the male trichinæ which are found in the human intestines is divided into two horns or cones, and that the same peculiarity exists in Pseudalius Duj.; but since, in every other respect, the structure of trichina entirely differs from that of Pseudalius, it is by no means probable, that M. Davaine's innovation will find favour with zoologists, as it would only lead to confusion; and, no doubt the worm in question will always be called by the name first given to it by Professor Owen.

Since its discovery in 1835, Trichina has been frequently noticed, more especially by German and English anatomists. In the anatomy rooms of the Universities of Berlin and Edinburgh, trichinæ have been found in 2 or 3 per cent. of the subjects dissected. Mr. Curling found them in the muscles of two robust men who were killed while in the apparent enjoyment of good health; one by fracture of the skull, the other by fracture of nearly all the ribs. The first was 58 years of age, the other 60. They were also noticed by several observers in Denmark, France, and the United States. The animals in which they have been found are the cat, the crow, the jackdaw, the hawk, the mole, the frog, the eel, the badger, the hedgehog, and the pig; but it is not yet settled whether some of the worms found in the former of these animals do not rather belong to a different species, viz., Trichina affinis. It was, however, only in 1860, that more minute investigations concerning the nature and development of trichina were undertaken, and Professors Virchow and Leuckart, who worked independently of one another, simultaneously come to nearly the same conclusions as regards the natural history of the worm. Zenker was the first to find, in a girl who had died at Dresden, numerous trichinæ in the striated muscles, and to recognise the parasite as cause of the illness and death of the patient. In the spring of 1862, about thirty cases of trichina disease occurred in Plauen, in Saxony. In some patients, small pieces of muscular tissue were excised and examined by the microscope, and thus, for the first time, the diagnosis of trichina disease was made in the living subject. Since then numerous cases of it have been observed, especially in Saxony, Prussia, and Brunswick. From the end of October to the middle of December, 1863, there was a true epidemic of this disease in Hettstädt, near Eisleben, in which 158 persons were affected, and twenty-eight of them died. It is, however, certain that the disease is not confined to the countries just mentioned; and no doubt many cases of it have occurred and do still occur in all parts of the world.

Dr. Tüngel has described an epidemic of trichinosis which occurred on board a merchant vessel, bound from Valparaiso to Hamburg. On leaving the former place, the cook of the ship bought a pig which was slaughtered, and part of which (about thirty pounds) was eaten by the crew; the rest of the animal was salted. Most of the crew fell ill, and two of them died. In a boy who died, and where an autopsy was made, numerous live trichinæ were found in the muscles. A piece of the salted pork was sent for examination to Professor Virchow, of Berlin, who

discovered in it a number of trichinæ, all of which were dead.

With the sole exception of Mr. Henry Wood's case, all observations made on human trichinæ until 1860, concerned those instances only in which the trichinæ disease had healed, that is, in which the worm had been seen in the encysted, not in the free state. We now know that, at least, two months are necessary for the production of a complete cyst, and that men or animals, which live so long that the trichinæ existing in them may become encysted, are likely to survive the disease. Before this was known, the opinion therefore gradually gained ground that trichina was a harmless animal, and more a curiosity than a source of danger. On this account, the practitioners and clinical observers took no further interest in the worm, which was left to the care of zoologists and anatomists. In a purely scientific point of view, however, trichina soon proved to be a problem of surpassing interest, as nobody knew whence it came, nor how it could migrate into the flesh of living men, nor how it was generated, for no organs of generation, no ova, no progeny had been found. It is, therefore, scarcely surprising that even good observers resorted to the old hypothesis of spontaneous or equivocal generation in order to explain the origin of trichina. Thus, Dr. Bristowe and Mr. Rainey believed that trichina was generated from fat formed between the muscular fibres, and that the nuclei, which became visible after the fat had gradually vanished, played an important part in those intermediate changes which occurred between the appearance of the animal and the disappearance of the fat.

In many respects trichina resembles cysticercus, which is most frequently found in pigs (measly pork), but is by no means rare in man. It is true, that cysticercus is larger than trichina; for while the former is of the size of a pea, or even of a small cherry or bean, the latter appears only as a little white speck, even if the cysts are taken together with the animal. On the other hand, however, cysticercus is, just as trichina, destitute of organs of generation and of ova; it often occurs in large numbers, and it is also found in the flesh. We know that cysticercus cellulosæ is the larval state of tænia solium (tape-worm); that, in fact, the same worm lives for some time as cysticercus, and is afterwards changed into tænia; that tænia produces not only ova, but also living progeny, which first become cysticerci, and afterwards are again metamorphosed into tæniæ. These facts, which went far to render the theory of spontaneous generation untenable, soon led zoologists to inquire whether or not similar processes might take place with regard to trichina. Virchow was the first who succeeded in showing, by experiments, the existence of alternate generation in trichina. He fed a dog with *encysted*, but still living, trichinæ, taken from a man, and found, four days afterwards, numerous *free* trichinæ in the intestines of the dog. These animals were seen to possess generative organs, containing ova and spermatozoa. He also showed that the cyst in which the animals are enclosed, when found in muscles, is nothing but a changed muscular fibre; and it thus became evident that the animals did indeed penetrate from without into the structural elements of muscles. These and other experiments of Virchow, which were confirmed by those of Leuckart, Claus, and others, have led to the conclusion, that there exists alternate generation for trichina as it does for cysticercus; that if animals are fed with trichinæ taken from the muscles, intestinal trichinæ are formed, which produce ova and living progeny; that these latter, without leaving the animal in which they have been generated, immediately penetrate the coats of the intestines and migrate into the body, more especially into the striated muscles, where, unless the animal in which they are contained should previously die, they are, after a time, encysted, and wait for the moment when they may be eaten by another man or animal, to undergo the same changes as before.

It thus appears, that the danger which may accrue to man from trichina is far greater than that with which he is threatened by cysticercus and tænia. While the latter require to be eaten on two several occasions, the former only requires to be eaten *once* in order to produce a progeny which infects the whole system. Moreover, cysticercus and tænia scarcely ever cause a fatal result, while even within the last three years a large number of deaths is known to have been brought about by trichinæ. A knowledge of the nature of the worm, of the symptoms of trichina disease, of the way in which this is brought about, and of the means by which we may hope to prevent or cure it, is, therefore, of considerable importance for the Medical Practitioner.

If men or animals have eaten meat infected with trichinæ, this is dissolved by the gastric juice, and the trichinæ become freed from their cysts. With a magnifying power of 200, we are

FIG. 3.

FIG. 4.

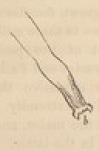


FIG. 3.—Magnifying power. 100. FIG. 4.—Magnifying power, 150.

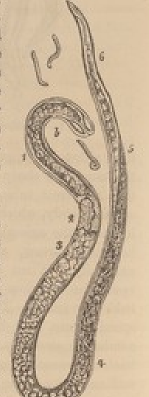
then able to distinguish their alimentary canal, which begins at the somewhat sharp anterior extremity of the animal; it is at first a narrow tube, but soon widens and appears as a broad cellular body, which fills up more than one-half of the whole length of the animal, while, at its posterior third, the tube again becomes narrow, and at last opens outside at the posterior extremity. When once in the stomach and freed from their cysts, the trichinæ awake from the torpor in which they were held previously. They begin to move about; they lose their spiral figure, and become stretched, so as to appear somewhat similar to ascarides. They soon grow rapidly, so that while a trichina musculorum is only from two-fifths to three-fifths of a millimeter long, the trichina intestini is no less than from one to three millimeters long. At the same time, generative organs are developed.

The male trichinæ may be recognised, by containing, in the posterior third of the body, glands with excretory ducts (Fig. 3, 2), and by having at the posterior extremity two prominences similar to thorns or cones (Fig. 3, *b* and Fig. 4, *b*). A full grown male trichina is from 1 to 1·5 millimeters long, and from 0·03 to

0·04 millimeters wide. It is probable that the males die soon after connexion has taken place; for while at first their number almost equals that of the females, it soon decreases, and from the tenth to the fourteenth day after the trichinous meat has come into the stomach only females are observed, which live longer than the males, as they require more time for maturing ova and producing progeny. Six weeks after feeding, no trace either of males or females is to be discovered in the intestines.

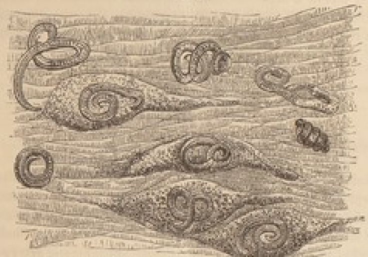
The full-grown females are considerably larger than the males, viz., from two to three millimeters. This is owing to the greater development of the posterior part of the body, the ovaries and Fallopian tubes being much more extensive than the testicles. The posterior extremity is more rounded than it is in the males, and is devoid of the cones found in the latter. Copulation takes place a few days after the animals have arrived in the stomach. In each ovum after a time an embryo is formed, which becomes free by rupture of the membrane enclosing the ovum, and travels towards the anterior part of the Fallopian tube (Fig. 5, 4—5). As soon as the embryo has arrived at the opening of that tube (5) it goes out and begins its individual existence. At this period, the embryo is very small and quite transparent; it is 0·05 millimeters long and 0·005 millimeters wide, and devoid of any special organs. The time required for the intra-Fallopian development of the embryo varies, according to Vogel, from two days to six weeks, the difference being obviously due to two causes. In the first instance, it appears that the development lasts longer if the trichinæ that have been eaten were very young; in the second place, the number of ova contained in one female must be taken into consideration. Most females contain from 300 to 500 ova, which only gradually advance towards the anterior opening of the Fallopian tube; and it is therefore evident, that more or less time must elapse between the birth of the first and the last of the progeny.

FIG. 5.



Soon after birth, the trichinæ leave the intestines and migrate into the peritoneal sac. For this they have to perforate the coats of the bowel, which, on account of their minute size, they probably accomplish without tearing the membranes, but merely driving them, as it were, asunder. This process is facilitated by the shape of their head, which may under certain circumstances become sharply pointed. From the peritoneal sac they proceed to all the striated muscles, excepting only the heart, in which they are scarcely ever found. They arrive in the muscles about ten days after their parents have been eaten, and penetrate through the sarcolemma into the interior of the muscular substance, which is, by their invasion, considerably altered. In moving through the fibres, the worms cause,

FIG. 6.



according to the researches of Virchow and Colberg, an acute parenchymatous inflammation of the muscular tissue; the fibres lose their stripes and gain a homogenous appearance; in others, the substance is changed into fine granules, small cells are formed in rapid proportion, and the nuclei increase in number and size. It is, however, only the fibres actually invaded by trichinæ, which undergo these modifications, while adjacent fibres, not touched by the worms, remain perfectly normal. If animals or men thus trichinised survive these multiple inflammations, convalescence sets in towards the fourth week from the commencement of the disease. The formation of small cells and nuclei gradually diminishes, new capillary vessels are formed, and from the nuclei even new muscular fibres may be generated, so that a nearly complete recovery may ensue. In cases of great severity where numerous trichinæ migrate into one muscular fibre, no regeneration can take place; in such cases there is fatty degeneration, not only of the contractile substance, but also of the nuclei of the muscles.

The parasites take their nourishment from the muscles in which they have taken up their abode. When they arrive in the muscles, they are furnished with a mouth, œsophagus, and intestinal canal; within a week, they grow so much that they attain thirty or forty times their previous size, which would be impossible if they did not assimilate a large amount of nutritive material from the man or animal which they have invaded. They then gradually become enclosed by a thick cyst, which is formed out of a firm substance deposited between the nuclei of the muscles, and which generally contains only one, but sometimes two or three, trichinæ. In proportion to the growth of

Fig. 7.

Fig. 7.—Magnifying power, 120. Trichina from the muscle of a dog, five months after the animal had eaten trichinæ. Earthy deposits at the upper extremity of the cyst, within which the worm is still visible.

the animal, it gradually assumes a spiral form similar to that of the spring of a watch. The time taken for these processes extends generally from the third to the fifth week. Within the next few months, further changes go on in the cysts. Chalk is deposited in them, first at one extremity (Fig. 7), and afterwards in the whole of the cysts (Fig. 8). This latter is then no longer

Fig. 8.

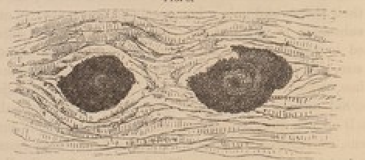


Fig. 8.—Magnifying power, 120. Piece of trichinous muscle from a human subject. Cysts completely calcified. The trichinæ within them only become visible after the lime has been dissolved by the addition of acetic acid.

transparent, and its coat appears very much thickened. In this state, it may be seen with the naked eye (Fig. 1). The flesh has a sandy feel, and on cutting it through with a knife it grates. The animal is now enclosed in a shell, like the egg of a bird. According to Vogel, the deposition of lime begins towards the fifth month. In those trichinæ which have been so frequently observed in the dissecting-rooms of Edinburgh, Berlin, etc., the cysts are generally completely calcified. Years may elapse before this occurs. In most cases, the trichinæ contained in these cysts still preserve their vitality, and are capable of development; if the lime is dissolved, and they are gently heated, they begin to move about; if given to animals to eat, they undergo all those changes which have been related above. Sometimes, however, the worm itself is calcified and dies.

The number of trichinæ which may be found in muscles varies exceedingly. In some cases, there are not many of them; in other instances, a piece of flesh not larger than a pin's head contains twenty or more. The sum total to be found in a man or an animal may amount to several millions. Six thousand millions of trichinæ only weigh one pound.

How should suspected Meat be examined for Trichinæ? From which Muscles should Specimens be taken?

I have already mentioned, that the cysts are visible to the naked eye as whitish, round, or ovoid specks, with which the surface of the muscle is sprinkled. If these are touched with a drop of acetic acid, or, better still, with diluted hydrochloric acid, the lime is dissolved and the white colouring disappears. This experiment is, however, not perfectly reliable, if larger pieces of flesh are examined; for the acid then produces a deposit from the muscular juice, whereby the whole surface becomes indistinct and turbid. It is, therefore, the best plan to cut off a very small piece of flesh with a fine pair of scissors, to tear this assunder with needles, and to free the cysts as much as possible from the flesh. If this is done on a glass resting on a dark object, the cysts may be clearly distinguished as whitish grains, and the dissolving power of acids becomes quite apparent. If the spots retain their colour, it is probable that small pieces of fat, nervous fibres, or similar formations are present. But as pieces of fat may be connected with the cysts, a negative result is not so decisive as a positive one; and it is, therefore, in doubtful cases always better to use the microscope in order to decide the point.

It does not matter very much from which muscles the pieces to be examined are taken. Even if there are only a few trichinæ present, they generally exist in all the muscles of the body, excepting the heart. The heart of pigs may therefore be eaten with impunity. Trichinæ are, however, more numerous in the tendinous extremities of the muscles, which is probably due to the circumstance, that a large number of trichinæ penetrate as far as possible in the muscular tissue, and only stop their progress if certain impediments (as tendons) offer. If we, therefore, wish to make the diagnosis of trichinosis in man, it is best to excise a little piece of flesh close to the insertion of a muscle.

Trichinæ which have not yet become encysted can only be recognised by means of the microscope. A thin layer of flesh should be cut out with a sharp scalpel, spread over a glass plate, and moistened with a drop of water. If it is then covered with a thin sheet of glass, we may distinguish trichinæ, if there are any, with a magnifying power of 50. Their intimate structure, however, can only be recognised with a power of 300.

Up to 1860, the diagnosis of Trichinosis had never been made in the living subject. In that year, however, Dr. Zencker, of Dresden, recognised an epidemic of this disease in the town and neighbourhood of Dresden, and showed the existence of trichinæ in a ham and several kinds of pork sausages of which the persons affected had eaten. The pig had been slaughtered at a country house near Dresden. The butcher and others who ate of it fell seriously ill; and one case, which was that of a servant-girl who had been quite well up to that time, ended fatally. At the autopsy, an immense number of trichinæ were discovered in all the muscles of the body. Dr. Zencker sent specimens of the ham, as well as of the muscles of the dead body, to Professor Virchow, of Berlin, who made a series of important experiments with them. A rabbit was fed with the trichinous meat, and died a month after. The autopsy showed that trichinæ had become developed in the muscles of the rabbit. Another rabbit was then fed with flesh from the first; and it also died a month after.

Flesh was again taken from the latter animal, and three other rabbits fed with it; two of these died in three weeks, the third a month after. From the latter, another rabbit was infected; it died six weeks after. In all of them the muscles were crowded with trichinæ, so that in every piece of flesh, however small, several worms were found. In order to be quite sure that there were no trichinæ in the rabbits before they ate the trichinous meat, Professor Virchow examined their muscular tissue before feeding them, and did not find a trace of trichinæ, which are, in fact, never observed in rabbits unless they are previously fed with trichinous meat. He also found trichinæ in the lymphatic glands of the intestines, the peritoneal sac, and the pericardium. Since then, numerous evidences of trichina disease have been recognised in Germany.

Symptoms of Trichina Disease.

The morbid symptoms caused by the immigration of trichinæ are interesting in a practical as well as in a scientific point of view. There are, in fact, few internal diseases where the cause of the disorder is so manifest, and where its action on the system may be so distinctly traced in all its successive stages.

Trichinosis is a more or less severe affection, according as few or many parasites are eaten, and a small or large progeny is produced. Thus, in the epidemic of Burg, near Magdeburg, a woman who had eaten a quantity of raw pork with bread, fell ill and died. Her child who had sucked a spoon used by the mother, had symptoms of mild trichinosis, and recovered.

Three stages of the distemper may be distinguished: the *first* of which comprises the time from the arrival of the worms in the intestines until the birth of the first of the progeny. This lasts from four to eight days; and its symptoms are, in certain cases, by no means remarkable, there being only loss of appetite and general *malaise*. But where the affection is severe, the patients suffer from considerable indigestion a few hours after the meal. There is a feeling of prostration, pain in the back and the stomach, fulness in the head, giddiness, aversion to food, sickness, and heat alternating with chills. On the second day vomiting and copious diarrhœa ensue, which latter continues for several days. The patients are laid up, and fever sets in towards the end of the first week.

The *second* stage is the most important one, and lasts from the time when the embryos commence their migration from the intestinal canal into the muscles, until they have taken up their permanent abode in the muscular tissue. The symptoms in this period vary a great deal according to the nature of the cases. Where the affection is severe, that is, where a large quantity of trichinous meat has been eaten, high fever and œdematous swelling of the face are the most striking symptoms. The latter sometimes affects the eyelids only; but in many cases it extends over the whole face, and is most considerable in women and children. At the same time, the conjunctiva is inflamed, the pupils are somewhat dilated; the faculty of accommodation is diminished; there is photophobia and pain on moving the eyes, especially on looking upwards. The fever is sometimes very high, even in the commencement of the second week. The pulse rises to 100 or 120; there are thirty-two or more respirations in the minute; the temperature is increased to 100° and more; the skin which was dry at first, becomes moist; there is profuse perspiration, and the patient complains of intolerable heat and thirst. Sleep is either wanting or much disturbed; the tongue is coated and rather dry, and the appetite quite gone. The urine is highly coloured, and contains sediments of uric acid; the quantity of urinary water is much diminished, the whole amount that is discharged within the twenty-four hours not exceeding eight ounces. There are from four to six motions during the day, but without pain or tenesmus; the abdomen is sensitive to touch, and there is a certain degree of meteorism. In women, the catamenia appear prematurely within the first few days of the second week; and if pregnant women are infected, miscarriage may take place. The temper of the patients becomes very irritable; towards night, there is increase of fever and slight delirium.

The symptoms caused by the parasites in the muscles themselves are not less striking. The muscles of the neck, back and limbs are rigid and swollen, the affection proceeding, in the majority of cases, in the direction from the centre towards the periphery; so that at first those of the arms and thighs, and afterwards those of the fore-arms and legs, hands and feet, become affected. Their bulk is increased, but pressure of the finger leaves no mark in the skin and cellular tissue. Pain is most severe if the patients attempt to extend the muscles; and it is more considerable at the first attempt to move, after they have been quiescent for a certain length of time. In cases of great severity, the muscular irritation is so considerable, that the patients lie flat on the back, without venturing to change their position, the extremities being slightly flexed. Muscles, which have special functions, are affected in a special manner. Thus, dyspnœa and singultus may be produced by trichinous infection of the diaphragm, the intercostals, and other muscles of respiration. If the muscles of the larynx are affected, there is hoarseness and loss of voice. By trichinosis of the tongue, and the muscles of mastication and deglutition, the processes of speaking, masticating, and swallowing, are impeded or rendered impossible; and sometimes there is true lock-jaw. The patients cannot laugh, yawn, or sneeze; and may be deaf in one or both ears.

The swelling of the face generally lasts only for one week, and then disappears without leaving any further traces; in a few cases, however, eruptions resembling urticaria, erythema, or rubeola have been observed to follow.

At the commencement of the fourth week, the severity of the fever increases still further; the pulse rises to 140 or more, the temperature to 104°, the number of respirations to 44 per minute. There is constant sleeplessness with great anxiety, fainting fits, and delirium; the perspiration continues profuse; miliary vesicles appear on the surface; meteorism, hæmoptysis, lobular pneumonia and effusions in the pleura may be observed. The pain is excessive, and twitches occur in the muscles; lock-jaw is severe, and the tongue cannot be protruded. At last the pulse becomes innumerable; and death ensues, with all the symptoms of complete exhaustion of the nervous centres. A fatal issue may take place four or five days after the commencement of the illness; but it mostly occurs during the third or fourth week.

In other cases, recovery sets in towards the fifth week. This is the *third stage* of trichina disease, and it commences as soon as the parasites have taken up their permanent abode in the substance of the muscles, and have coiled themselves up and become encysted. The fever then diminishes, the pulse falls to 96 or even 84; the number of respirations to 32 or even 24, the temperature to 99°. Perspiration becomes less profuse, diuresis is increased, there is less thirst, the tongue becomes moist, the patients are again able to sleep, and the pain gradually disappears. The appetite returns slowly, but sometimes the patients are so voracious, that they require many meals in the day as well as at night. They soon gain flesh, the skin peels off, the body-weight increases, and they begin to walk about again. The pupils still remain dilated, the conjunctiva inflamed, the faculty of accommodation diminished; and œdema in the lower extremities, occasional pain in the chest and dyspnœa are troublesome. About the seventh week, most patients are able to return to their business. Depilation, however, begins at the eighth week, and in women amenorrhœa, and murmurs in the jugular veins, show that health is, even then, not entirely re-established. Where inflammation of the lungs has occurred, and the result has not been fatal, recovery may be protracted to the tenth week, and even longer.

In certain mild cases, the first symptom of the *second stage* of trichinosis is violent palpitations of the heart, but no other striking appearances. In other instances, œdema of the face, a feeling of great weakness, pain in the muscles, and impaired digestion are observed towards the end of the second week. Such patients are not even laid up; yet the affection may be insidious, and death ensue of pneumonia or peritonitis three or four weeks after the commencement of the disease.

A curious fact is, that children, especially those under 14 years of age, suffer far less than adults. This may be partly due to the circumstance, that less meat is given them, and, consequently, a smaller number of parasites immigrates into their system; but it is, no doubt, also in great part owing to the higher sensibility of the stomach and bowels. After the unclean meal, children frequently vomit or purge, whereby the dangerous substances are evacuated soon after having been introduced; so that there is not sufficient time allowed for the worms to infect the system.

But even where the affection is severe, children do not actually suffer so much as adults, as regards pain, thirst, and sleeplessness. The œdema of the face is generally very extensive, and there is a high degree of mydriasis which lasts for two months; but children mostly sleep the disease off, as it were, being scarcely ever awake; their appetite is not quite gone, and

recovery sets in sooner. In the Hettstädt epidemic, only one child died, and she had obstinately refused to take medicine.

Post-Mortem Appearances.

There is much emaciation; the muscles are moderately rigid; hypostatic swellings are observed, especially at the neck; and a certain degree of decubitus at the sacrum. The muscles are pale and dry, and contain, according to the period in which death resulted, either free or encysted trichinæ. The blood in the heart and great vessels is dark and thin; clots may be found chiefly in the saphena, basilic, and cephalic veins. There is moderate aqueous effusion in the pericardium. In the right ventricle, firm clots of fibrine two or three inches long may be present, and extend into the pulmonary artery. The heart itself is soft and flabby, and the mucous membrane of the respiratory organs pale. The posterior and inferior parts of the lungs are hyperæmic, and, in cases where pneumonia has been recognised during life, the usual signs of metastatic (embolic) inflammation are present. In the pleural sac there is, in such cases, a sanguineous effusion, and fibrinous clots adhere to the visceral pleura, as far as it covers the inflamed portion of the lung. There is a firm reddish-brown cuneiform infarctus in the pulmonary tissue looking with its base towards the periphery, and with its apex towards the centre. The branches of the pulmonary artery which proceed to this infarctus, are blocked up with embolic clots. Where death is not the result of pneumonia, but of paralysis of the respiratory movements, portions of the lung are in an atelectatic condition. The peritonæum shows no traces of inflammation; the spleen is not enlarged, but soft; the liver anæmic; the gall-bladder flabby and full of bile; the stomach is flabby, its mucous membrane pale, and it sometimes contains ecchymoses. There is no swelling of the solitary follicles of the intestine, nor of Peyer's glands. The kidneys are anæmic and soft, the bladder normal. The state of the nervous centres has not yet been examined.

Remarks on some Special Symptoms of Trichinosis, and their Physiological Explanation.

One of the most important symptoms is, as I have already stated, the œdematous swelling of the face, which is mainly produced by trichinous inflammation of the muscles of the face and the eye, and their interstitial connective tissue. By this the circulation of the blood in the skin and the cellular tissue is disturbed, just as is the case after external injuries, etc.; and this continues until the cysts are formed. The muscles of the eye are almost always full of trichinæ. In one specimen taken from the obliquus inferior muscle, Dr. Rupprecht found no less than forty-nine of them. In the majority of cases, the œdema commences on the seventh or eighth day after infection; from which it would appear, that the velocity with which the worms move within the system, is about one-third of an inch per hour; the migration being commenced on the fourth day from the bowel, and having reached the eyes at the end of the first week. If the eyes are examined with the aid of the opthalmoscope, it is seen that there is also œdema of the optic nerve and its papilla; the vessels of the retina are enlarged and may be seen pulsating, even in anæmic patients; the macula lutea is not visible, and the edge of the papilla is very indistinct. At the same time, there is mydriasis, and the eyeball is softer than usual.

The diminished state of the faculty of accommodation, and the pain attendant on movements of the eyes, arise from the same cause. Towards the fourth week, there may be almost complete paralysis of the faculty of accommodation, which latter returns to its normal state only within the third month, or even later.

The œdema of the lower extremities is, if it occurs at an early period, due to the same cause as above; but if observed at a later time, it arises from the formation of clots in the veins, which is promoted by the long inactivity of the muscles and consequent disturbance of venous circulation. In certain cases, small pieces of these clots are torn off and lodged as emboli in the branches of the pulmonal artery, whereby fatal inflammation of the lungs may be produced. In the Hettstädt epidemic this occurred in one case out of sixteen; and it has also occurred elsewhere. Mr. Henry Wood's patient (p. 8), and Zencker's patient (p. 18) died of it; other such instances have been observed in Plauen and Blankenburg.

Towards the fourth week, extensive œdema of the neck is sometimes suddenly produced, and threatens life by causing hyperæmia of the brain. In the Hettstädt epidemic, three

patients died in consequence of this. They were all well-fed, stout persons.

Œdema of the glottis may ensue by trichinous infection of the crico-thyroid and crico-arytænoid muscles. If deafness is present, it arises from infection of the salpingo-pharyngeus and pharyngo-palatinus muscles, whereby œdema of the mucous membrane, and closure of the Eustachian tube, are caused.

We know that any stimulus applied to a living muscle produces contraction. It is, therefore, only after the inflammatory symptoms have subsided, that relaxation of the muscles occurs in trichinous patients. In certain cases, there is true trismus and tetanic rigidity. It has not yet been explained why, in this affection, adults always lie on the back, and children on the side, both without changing position.

The great acceleration of respiratory movements is partly caused by the fever, and partly by trichinous affections of the intercostal muscles, the diaphragm, and other muscles of respiration. Coughing, sneezing, yawning or laughing are sometimes prevented, while, in other cases, singultus and fits of yawning and sneezing take place. These symptoms are, however, by no means constant, and, if present, only occur during the fourth week.

The palpitations of the heart, which are in certain cases, of exceeding violence at the commencement of the second week, are probably caused by a temporary trichinous infection of the pericardium and the heart. They occur in about one case out of thirteen. It seems, however, that the trichinæ soon leave the heart, for these palpitations generally cease in the course of the second week; and in autopsies, it is quite exceptional, that any worms are discovered in that organ.

By immigration of trichinæ into the abdominal muscles, constipation and diminished power of discharging the urine may be caused.

Perspiration is mostly profuse for several weeks; and it may continue in certain parts of the body—such as the neck, the left arm, etc., after the general perspiration has ceased. It seems that those parts are chiefly subject to it, the muscles of which are extensively infested.

Premature appearance of the catamenia is the rule, but miscarriage not the necessary consequence of trichinosis. A case occurred in the Hettstädt epidemic, where a fœtus six months old was born a few hours before the death of the mother, which was caused by peritonitis. In this case, a post-mortem examination was made, and no trichinæ were found either in the womb, or in the muscles of the fœtus. It is, therefore, probable, that the effects on the womb are caused by irritation of the adjacent organs.

Causes of Trichina Disease.

Trichinosis in man is probably always caused by eating raw or underdone pork, ham, and sausages. Beef, mutton, poultry, game, etc., never contain trichinæ, and those other animals in which the parasites have been found (viz., the cat, mole, crow, hawk, and jackdaw, etc.), are scarcely ever eaten. In Paris, however, where cat's flesh is notoriously served up in certain *cabarets*, men may become infected with trichinæ by eating such ragouts.

The wisdom of Moses in forbidding the Jews to eat pork * has thus received an additional striking proof. It may be that Moses forbade pork to be eaten because pigs take unclean and putrid food; but it is just as possible that he may have done so after having observed people fall ill and die after eating pork. In the less complicated conditions of social life at that time, observations on the effects of poisonous meat could be made with far greater facility than is possible now; and if a large number of persons fell ill or died after partaking of meat from one slaughtered animal, the cause of the accident must needs have struck an accurate observer.

Some years ago, when it was shown that tapeworm in man is caused by eating pork containing cysticerci, it was believed that Moses' law regarding pork was made for the prevention of tapeworm; but tapeworm seldom causes considerable illness: it is not really dangerous to life; and if pork was forbidden from a knowledge that it produced disease, it is far more probable that the law was meant for preventing that disease which is now known to us as trichinosis.

* Leviticus, xi. 7—8: "And the swine, though he divide the hoof and be cloven-footed, yet he cheweth not the cud; he is unclean to you. Of their flesh shall ye not eat; and their carcase shall ye not touch." The same is repeated, Deuteronomy xiv. 8.

Diagnosis.

The *diagnosis* of flesh-worm disease may, in somewhat severe cases, be easily made during life. The course and the symptoms of the distemper are, in fact, very peculiar. In mild cases, there are gastric disturbances, pain in the muscles, and œdema of the face. In severe cases, there are, besides these symptoms, swellings of the muscles, fever of a typhoid character, but no tumour of the spleen. There is, moreover, dyspnœa and hoarseness. If, under such circumstances, the patient admits of having a short time ago eaten raw or underdone pork, ham, or sausages, and especially if several patients are affected at the same time in the same house, or in the same neighbourhood, there is every probability of the disease being trichinosis. Absolute certainty, however, is only to be acquired by finding trichinæ either in the evacuations or in the muscular tissue.

To show trichinæ in the evacuations is very troublesome to the Physician, and to show them in muscular tissue not very pleasant to the patient. If the fæces are not fluid, water must

FIG. 9.

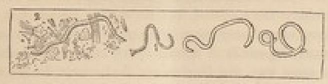


FIG. 9.—Intestinal trichinæ from a young dog five days after having been fed with trichinous meat. 1 is a male trichina, with cones at its posterior extremity; the others are females. At 2 the parasite is surrounded with fæcal matter.

be added to them, and the matter is then brought, drop by drop, upon the object-glass. With a magnifying power of 20, we may be able to find intestinal trichinæ; but the examination takes several hours to accomplish, and often yields no result, although the patient is infected with the parasites.

For showing the presence of trichinæ in muscles, it is necessary (unless there should be, by chance, an open wound in which a muscle is laid bare) to take out a small piece of any muscle and examine it. The operation may be done by Middeldorpff's harpoon, or a small incision may be made at the lower portion of the deltoid, where issues are usually made, and a piece of flesh the size of a lentil may be cut out by a pair of scissors. If there are any muscular swellings, it is best to take the specimen from the muscles thus affected, and examine it with the

FIG. 10.

FIG. 10.—Magnifying power, 19. A piece of muscle rendered transparent by the addition of acetic acid. There are two encysted trichinæ in the middle; the others are free.

microscope. Such a proceeding is by no means dangerous, and quite justifiable. If the disease is severe, the first specimen taken generally contains trichinæ. If certain muscles are more swollen than others, it is best to take specimens from the former. Where the cysts are calcified, no magnifying power is necessary. If the trichinæ are encysted, but no earthy deposit has as yet taken place, an ordinary magnifying-glass shows them in a distinct manner, especially if diluted hydrochloric acid is added.

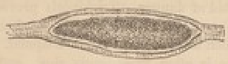
In the same way, the diagnosis of flesh-worm disease may be made long after it has healed in persons who have recovered from the affection. A curious fact of this kind has been recorded by Dr. Griepenkerl. From 1859 to 1862, an epidemic occurred in Blankenburg, in the Duchy of Brunswick, which the medical men of the place believed to be one of gastro-rheumatic fever. Some time afterwards, when public attention had been directed to the occurrence of trichina disease in other parts of Germany, the similarity of the latter distemper and the epidemic just mentioned, struck the doctors of Blankenburg; and a gentleman who had fallen ill there in 1859, but had recovered, after a very protracted illness, was informed by his medical attendant that the disease from which he had then suffered, had, probably, been trichina disease, and that traces of it might yet be found in his body. The gentleman then offered to have a small piece of muscle cut

out, and on this being done, and the specimen being examined by the microscope, no less than seven encysted trichinæ were found in it. It was thus satisfactorily shown that the Blankenburg epidemic, in which no less than 278 soldiers, and a corresponding number of civilians had fallen ill, had, in reality, been nothing but trichina disease.

It has been asserted, that trichinæ might be most readily recognised in the mucous membrane of the tongue of trichinous patients. This, however, is erroneous; for neither with the naked eye, nor with an ordinary magnifying glass are we able to distinguish the worms, even if they should exist in that part. It is only long after the disease has healed, and when the diagnosis has no longer any immediate practical interest, *i. e.*, after the complete formation and calcification of the cysts, that we might be enabled to distinguish these latter in the tongue, with the naked eye or a magnifying glass.

The only formations which may possibly be confounded with trichina-cysts are the so-called Rainey's corpuscles, which are

FIG. 11.



sometimes found in the muscular fibres of the pig, and have received their name from having been first described by Mr. Rainey. They consist of a dark granular mass, enclosed by a transparent ovoid cyst, and are found imbedded in the interior or primitive muscular fibres, which are thereby somewhat dilated. The nature and mode of development of these formations are at present unknown. It is only certain that they have nothing to do with trichinæ, and they never enclose a worm; so that an accurate observer will always be able to distinguish them from trichina-cysts. Rainey's corpuscles are never found in human muscles.

The *prognosis* of a case of trichinosis depends upon the circumstance whether the person affected has eaten few or many trichinæ. Where few have been eaten, the patients may feel unwell; but they soon recover. Even in cases of medium severity, a fatal issue is rare, and after an illness of a few weeks convalescence sets in. Cases of great severity either end fatally, or the patients very slowly recover, after having been dangerously ill for weeks, and they remain weak and out of health for months afterwards. Of special importance for prognosis are the muscular pains and the fever; if both are severe, the prognosis is bad, or at least doubtful.

The average rate of pulsation in this disease is from 84 to 96, that of respiration 32, the average temperature 100°. Any increase in these numbers forebodes evil. If the pulse is 120 at the commencement of the disease, and remains so for a certain length of time, the patients are generally doomed. Where, however, this pulse is only observed for a few days, and the patients are not laid up at the same time, it is not a dangerous symptom. If the temperature suddenly falls to 98° on the 28th or 35th day of the disease, the patients may be said to be in a fair way of recovery. But, where they lie motionless on the back; where a sensation of tingling is felt in the extremities; where there is tetanic rigidity of the trunk; and where delirium, and sopor and coma supervene, death is approaching. Pneumonia in the fourth week of the complaint is mostly fatal, but pleurisy is devoid of danger. Trichinosis proves more fatal to women than to men and children. The third and fourth weeks are those in which a fatal issue is most frequent.

Convalescence is often exceedingly slow, and protracted by diarrhoea and blennorrhoea of the lungs. Patients once affected by the disease, are not in any way insured against a future infection. Whether the encysted trichinæ, which must always remain in the system, if it has once been infested by them, may, at a later period of life give rise to other disorders, we have, as yet, no sufficient data to decide. It is a curious coincidence, that the patient in whose body Mr. Hilton first discovered trichina cysts, had died of cancer; that the patient on whom Professor Langenbeck operated (p. 7) suffered from a similar tumour; and a third instance is on record where Professor Blasius, of Halle, found trichina cysts in the muscles of a man who had died of epithelial cancer. It is, however, at present impossible to say, whether this is a mere coincidence, or whether there is any connection, as between cause and effect. It would, at all events, be worth while to examine the muscles of patients who have died of cancer, in order to ascertain whether there is a frequent coincidence. As any mechanical

irritation, especially if long continued, is liable to cause cancer, the innumerable trichina cysts, which are interspersed between the muscular fibres, may possibly produce analogous effects.

Treatment.

As regards the *treatment* of trichinosis, the results have, up to the present time, not been very satisfactory. Many patients have died in spite of treatment; and those who recovered would probably have done so without special treatment. Professor Friedreich has recommended using the picro-nitrate of potash, which, in a case he had under his care, appeared to exercise a most beneficial action; but further experiments by Dr. Fiedler and Professor Mosler have shown that this substance, even if given in large doses, kills neither the intestinal nor the muscular trichinæ, nor does it prevent the immigration of the parasites into the substance of the muscles; so that a further use of that remedy in trichinosis does not appear justifiable. Arsenic has been given, but without success. On the other hand, Professor Mosler has found, as the result of careful experiments, that benzine (or benzole) is a poison for trichinæ. Benzine was discovered by Faraday, in 1825, and is represented by the formula

$$C_{12}{}^{H_5}_{H.}$$

It rapidly kills lice and other vermin, and seems to have the same effect upon cysticercus and trichina. But benzine is also a powerful poison for large animals and man; and, if used in the treatment of trichinosis, should be employed with special caution. A rabbit can take ten grains, a pig thirty grains, and a cow half an ounce of benzine per diem without its producing alarming symptoms of poisoning. From thirty to forty drops may be given to an adult man *pro dosi*, and, as the smell and taste of this substance are peculiarly nauseous, Professor Mosler has recommended it to be given in the form of "*capsules gélatineuses*," each capsule to contain ten drops, and one to be taken every two hours. Up to the present time, benzine has not yet been employed in trichinosis in man; but its use in the more severe forms of this affection seems justifiable. It would, however, be most desirable to discover an efficacious drug which is less noxious to the system than benzine.

In most cast cases, a symptomatic treatment must be resorted to. If the practitioner should be called in soon after the taking of trichinous or merely suspicious meat, an emetic should be given at once. At a later period, neither emetics nor purgatives seem to do much good. The experiments of Fiedler go far to show, that even large doses of purgatives have no influence in removing trichinæ from the intestinal canal, nor to prevent the development of the embryos and their immigration into the muscles. On the other hand, Dr. Rupprecht has seen relief following the administration of calomel in scruple doses, and has discovered one female trichina and two embryos in the fæces of a patient who had previously taken calomel. He also mentions, that the fever was not so severe if this treatment was resorted to in the beginning; and the diarrhœa was often stopped by it. He follows the calomel up by an emulsion of sweet oil of almonds, with arabic gum and laurel water, which he believes to be noxious to those trichinæ which may still be present in the bowel, and at the same time to soothe intestinal irritation. At the commencement of the third week, he recommends half a grain of hydrochlorate of quinine, in solution, every two or three hours. By this remedy, the temperature and perspiration were much diminished, and the vital powers roused. Mineral acids and digitalis have been recommended by some observers, but forbidden by others. A free administration of milk, beef-tea, and alcohol, if it is borne, should, in all cases, be resorted to. Liebig's extract of meat has, in some cases, proved very useful. Animals infected by trichinæ seem to die chiefly in consequence of being, by the painful affection of the muscles of mastication and deglutition, prevented from taking food; and they live much longer, if milk and other nutritious fluids are injected into the stomach. The same holds good for man, especially in cases where high fever exhausts the frame. To most patients, the idea "of being eaten alive by worms" is so revolting, that it is better to keep them in ignorance of the nature of the complaint.

Amongst the several symptoms of trichina disease, which require relief, sleeplessness is one of the most troublesome. Morphia fails to afford benefit, and only increases the restlessness and diarrhœa. In certain cases, enveloping the patients in wet sheets has done good, and the rooms should always be kept very cool. Bromide of potassium has not yet been tried, but would probably do good. Diarrhœa often continues throughout the disease, and resists opium and astringents; an occasional dose of castor oil is sometimes beneficial. If there is constipation, castor oil may also be given. For perspiration which is very profuse, wet sheets and quinine, or fomentations with vinegar have been beneficially employed. If œdema is troublesome, and diuresis much diminished, juniper oil or turpentine may be administered. For the muscular pains, tepid fomentations, or frictions with oil of hyoscyamus or benzine, should be used.

In the third stage of the affection, the patient should be treated according to general rules. If anæmia or hydræmia is present, tonics, especially iron, should be freely given; if there is stiffness, weakness, and atrophy of the muscles, tepid baths and Faradisation are to be employed.

The old adage that *prevention is better than cure* was never more applicable than to trichinosis. This disease would, in fact, never occur, in the human species, were pork eschewed. This being one of the cheapest meats, it is not likely that its use will be discontinued by the poor; but they might at least be taught the necessity of taking every precaution against the ill effects which may ensue. It has been shown that if pork, ham, or sausages are thoroughly well roasted, boiled, smoked, or salted, all trichinæ which may be present are destroyed. A temperature at which albumen coagulates (144° to 164° F.) kills the parasites; but it is often only the external layers of the joint or the cutlet which undergo this or a greater heat, and the inner fibres generally remain underdone. In these latter, therefore, the blood and albumen are not coagulated; they are soft and of a pinkish hue, and may contain a large number of live trichinæ. On the other hand, it has been shown by the experiments of Küchenmeister, that if pork is salted for a certain length of time, or if sausages are subjected to hot smoke for twenty-four hours, the trichinæ are killed. Cold smoking does not kill them unless it is continued for a long period; but when sausages which have been subjected to cold smoking are kept for a long time, the life of the parasites generally seems to be extinct.

It now only remains to be seen, what measures of precaution should be adopted by communities against trichinous infection. The following points are the most important for this consideration:—1st. Great cleanliness of the sties in which pigs are kept should be observed; and, as pigs can only become infected by eating meat or fæces containing trichinæ, they should, as far as possible, be prevented from taking suspicious animal substances. 2nd. A microscopical examination of pork should be made before it is offered for sale, either by Medical men, Veterinary Surgeons, or Naturalists, who should be paid for their services either by the pork-butchers or by the municipal government. In large towns, each district should have a special slaughter-house for pigs, to which a microscopist should be attached, and no pork should be allowed to pass out without a certificate of its being uninfected. A full examination of one animal may be made in ten minutes by a good observer. In small country places, curates, schoolmasters and others conversant with the use of the microscope, might undertake the office.

Pork-butchers should not oppose such examinations, as it is they who are in the first instance exposed to the danger. In almost all epidemics which have occurred in Germany, pork-butchers, their wives, children, and servants were the first to suffer. In several German towns, pork-butchers therefore employ competent observers to examine all animals before offering them for sale; and the meat is therefore guaranteed pure to the public.

In concluding this paper, I have much pleasure in stating that the Medical Department of the Privy Council are fully alive to the importance of the subject, and are taking it into their serious consideration.

THE END.

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Ueber

Desinfection

und gleichzeitige

Stoffgewinnung

auf mechanischem Wege,

in ihren Beziehungen

zur

Sanität und Oeconomie

nebst

Angabe von Maßregeln des allgemeinen und persönlichen Schutzes in inficirten Zeiten,

von

Dr. Johann Waltl,

k. b. Militärarzte.

München, 1861.

Verlag von G. Franz.

Inhalt.

Vorwort.

Die Wichtigkeit des nachfolgenden Gegenstandes in Verbindung mit dem redlichen Willen, „nützen zu wollen,“ und dem Glauben, „nützen zu können,“ gibt dem Verfasser den Muth, die Resultate seiner bezüglichen Beobachtungen und Experimente, seine Anschauungen über diese noch schwebenden Fragen dem Publicum zur Beurtheilung und eventuellen Nutzanwendung hiemit zu übergeben.

Wenn Vieles nur angedeutet ist, Anderes nicht die Exactheit der Wage zeigt, so liegt der Grund hievon darin, daß er für die Allgemeinheit, nicht aber für eine Specialtät schreiben wollte. Wäre Alles bis in's Kleine ausgesponnen worden, so würde ein dickes Buch entstanden sein, worin in langer und breiter Weise nur größere Kreise um dieselben Puncte gezogen worden wären.

Wenn auch Mancher mit den Anschauungen über die Entstehung der Malaria und Cholera und über die Mittel und Wege der Abhülfe hievon sich nicht einverstanden erklären könnte, so wird darum die Abhandlung noch nicht allen Werth für ihn verloren haben, indem er sich vielleicht für die Stoffgewinnung bei möglichster Vereinfachung der Arbeit und für die Mittel des persönlichen Schutzes bei herrschenden Seuchen sowohl als im Allgemeinen — oder umgekehrt wird interessiren können.

Die vorkommenden Wiederholungen sind nicht zufällige oder unachtsame, sondern sie sind beabsichtigte. Der Verfasser glaubte nämlich auf gewisse Momente, welche ihm die entscheidenden zu sein scheinen, möglichst oft zurückkommen zu müssen, um sie durch Wiederholung geläufig zu machen.

„Zu nützen" war seine Absicht.

In diesem Sinne wolle die Abhandlung aufgenommen und beurtheilt werden.

Der Verfasser.

Einleitung.

Die Noth, diese erste Lehrerin der Menschheit, der Inbegriff von Hunger und Krankheit, war es, welche die Menschen nöthigte, auf sich selbst, auf ihre Umgebungen und auf die Wechselbeziehungen beider, welche im Jahreslaufe sich ergeben, ihre Aufmerksamkeit zu richten. Ein geringerer Zwang als das Auftreten von Seuchen und das Nachlassen der Fruchtbarkeit unserer Felder, würde auch kaum hingereicht haben, die Anstrengungen hervorzurufen, welche zur Erforschung der hiebei obwaltenden Verhältnisse nothwendig waren.

Im Allgemeinen aber haben die sonst so mächtigen Hebel der Noth und des Interesses noch nicht vermocht, dieser Sache jene Aufmerksamkeit und Beachtung zu verschaffen, welche sie verdient.

Das wiederholte Auftreten der Cholera und des gelben Fiebers, das jährliche Wiedererscheinen der Malariaseuche (des Wechsel- des kalten Fiebers), haben die Wissenschaft neuerdings zur Beobachtung und Forschung angespornt, um — sie vom Einwirkungsorte an durch ihre Verbreitungswege mit Berücksichtigung aller hiebei obwaltenden Verhältnisse in subjectiver, tellurischer und atmosphärischer Beziehung verfolgend — ihre Entstehung und damit zugleich die Mittel zur Abhülfe hievon zu erforschen.

Den Professoren Liebig und Pettenkofer gebührt das Verdienst in Erforschung dieser Verhältnisse und in der Würdigung derselben vorangegangen zu sein. Pettenkofer in Bezug auf Sanität, Liebig hinsichtlich der Oeconomie.

Pettenkofer schlug hiezu den einfachsten, natürlichsten und zugleich einzig richtigen Weg ein. Er begann seine Forschungen am Orte der stattgehabten Infection und griff zur Erklärung dieser traurigen Erscheinungen nicht in alle Lüfte und nach allen Welttheilen.

Nach seinen Beobachtungen steht das Auftreten und die Verbreitung der Cholera in Beziehung zum Rückbildungs-Prozesse der organischen Stoffe, welche sich in unseren Wohnhäusern und deren Umgebungen aus den organischen Abfällen und Auswurfsstoffen ansammeln. Er hat gezeigt, daß jene Häuser und Häusergruppen am schwersten von dieser Krankheit betroffen wurden, welche aus Mangel an Abfluß der Auswurfsstoffe am meisten in Koth und Schmutz stacken.

Nachdem nun die Thatsache feststeht, daß Häuser obiger Eigenschaften den Angriffen und Verheerungen dieser Krankheit am meisten ausgesetzt sind, so stellt sich die Aufgabe heraus, die Gründe für diese Erscheinung zu erforschen.

Als Thatsächliches ist vorher noch zu erwähnen, daß diese Seuchen immer zur heißen Jahreszeit, bei anhaltend schönem Wetter, somit bei größerer (relativer) Trockenheit, mit dem Fallen des allgemeinen Wasserniveau's erscheinen und mit dem Eintritte der kälteren Jahreszeit, oder größern Wasserreichthums, mit dem Steigen des Wasserniveau's wieder aufhören.

Unsere Betrachtung wird sich daher erstrecken müssen:

I. auf die Rückbildungswege der organischen Materien und auf die Einwirkung ihrer Produkte,
II. auf die Wichtigkeit und Nothwendigkeit der Stoffgewinnung,
III. auf die Mittel zur Desinfection und Stoffgewinnung, und
IV. auf die Maßnahmen bei bereits ausgebrochenen Seuchen.

I.

Rückbildungswege der organischen Stoffe.

Alle organischen Gebilde des Thier- und Pflanzenreiches betreten, sobald sie aus dem Leben geschieden sind oder in ihnen das Leben erloschen ist, den Weg der Rückbildung,

welcher als vollendet erst dann zu betrachten ist, wenn sie bei den einfachsten anorganischen Verbindungen angekommen sind, aus welchen sie hervorgegangen: wenn sie zu permanenten Gasen, zu Wasser, zu Salzen und zu Elementen geworden sind. Eine Ausnahme hievon machen nur die Samen (die Harze); diese sind zwar aus dem Leben geschieden, insoferne sie die Mutterpflanze verlassen haben, allein sie sind selbst mit Leben, wenigstens mit latentem, begabt und gehören daher nicht zu den organischen Körpern, die auf dem Rückbildungswege begriffen sind.

Der Rückbildungsproceß der übrigen organischen Stoffe kann beschleunigt, verlangsamt und sistirt werden.

Die Rückbildung der organischen Stoffe geschieht auf drei Wegen:

1. auf dem der Verbrennung,
2. auf dem der Fäulniß, und
3. auf dem der Verwesung.

1.

Die schnellere oder langsamere Rückbildung ist bedingt durch den Temperaturgrad und die Menge der dargebotenen Luft (Sauerstoffs).

Bei der Rückbildung auf dem Wege der Verbrennung sind diese Bedingnisse vollständig erfüllt. Durch den Temperaturgrad, welcher zum Verbrennen der Stoffe nothwendig ist, werden die Bande der Organisation gelöst und die Elemente der organisirten Körper verbinden sich mit den bei ihrer Organisation ausgeschiedenen Sauerstoffprocenten zu den einfachsten, permanenten unorganischen Verbindungen, oder scheiden unverbunden als Elemente aus. Dieser Rückbildungsweg wird rasch zurückgelegt. Es ist gleichsam der Fall der Körper von ihrer organischen Höhe zur anorganischen Basis, von welcher sie emporgewachsen waren.

„Die Producte des Rückbildungsprozesses auf dem „Wege der Verbrennung sind weder übelriechend noch „schädlich."

2.

Der zweite Rückbildungsweg ist jener der Fäulniß. Er ist dem vorigen gerade entgegengesetzt. Auf diesem geschieht die Rückbildung sehr langsam, weil bei niedriger Temperatur und bei nahezu vollständig abgeschlossener Luft.

Bei diesem Prozesse, der unter Wasser (Erde) stattfindet, lösen sich die Bande der Organisation langsam und die Stoffe gehen wegen Mangels an Luft neue, einfachere Verbindungen unter sich ein. Es ist das stufenweise Herabsteigen der organischen Körper vom Gipfel der Organisation zur anorganischen Basis, wobei eine Verflüchtigung der Rückbildungsproducte erst auf der vorletzten Stufe und von der Basis aus erfolgt, z. B. Ammoniak, Schwefel- und Phosphorwasserstoff. Ist der in den Stoffen vermöge ihrer Organisation gegebene Sauerstoff verbraucht, so tritt der Wasserstoff derselben vicariirend an dessen Stelle. Es entstehen statt der einfachen Verbrennungs- (Sauerstoffs) Producte eine Menge Fäulniß- (Wasserstoffs-) Producte. Diese Verbindungen sind zwar schon sehr einfache, aber noch keine permanenten, so daß sie sich, sobald Gelegenheit hiezu gegeben wird, in solche umwandeln. Diese wird ihnen vermöge ihrer Eigenschaft als Gase, sobald die deckende Flüssigkeit, unter welcher ihre Rückbildung stattfand, gesättigt ist oder der Luftdruck sich vermindert, indem sie sich dann verflüchtigen und in der Luft ihre weitere Rückbildung fortsetzen. Daher der üble Geruch, wenn Kloakenmassen bewegt werden oder schlechtes Wetter eintritt.

„Die Producte der Fäulniß sind theilweise übel-
„riechend aber in der gewöhnlich vorkommenden Ver-
„dünnung eben so wenig schädlich als die Kohlensäure
„der Luft, welche concentrirt eingeathmet tödtlich wirkt."

3.

Zwischen diesen beiden liegt der dritte Rückbildungsweg, jener der Verwesung.

Dieser ist nicht constant derselbe, wie jener der Verbrennung und Fäulniß, sondern verläuft zwischen ihnen in

gebogener Linie, indem er aus jenem der Fäulniß entspringt, sich verschieden weit davon entfernt und ohne den der Verbrennung je erreichen zu können, wieder auf den Fäulnißweg zurückkehrt. Er unterscheidet sich von dem Prozesse des Verbrennungsweges durch geringere Temperatur und von jenem der Fäulniß durch höhere und durch Luftzutritt. Es ist das Herabgleiten der organischen Körper vom Organisationsgipfel bis zu irgend einer Rückbildungsstufe, von wo aus sich die Producte derselben verflüchtigen und ihre weitere Stufenleiter in der Luft zurücklegen. Bei dem Verwesungsprozesse liegen die organischen Stoffe in feuchtem Zustande den Einwirkungen der verschiedenen Temperaturgrade und der Luft offen.

„Die Producte derselben sind die der unvollkomme-
„nen Verbrennung, somit übelriechend und schädlich."

Eine Talgkerze z. B. verbreitet, so lange sie brennt, keinen Geruch, ausgeblasen aber, mit fortglimmendem Dochte verursacht sie Gestank, welcher von halbverbranntem Talge herrührt.

Die Schädlichkeit der Producte des Verwesungsprozesses steht in geradem Verhältnisse zum Grade der Temperatur und zur Dauer ihrer Einwirkung.

Bei anhaltend schönem Wetter entwickelt sich eine so hohe Temperatur, daß die durch Wasserabfluß und Verdunstung zu Tage tretenden organischen Massen in einen raschen Rückbildungsproceß versetzt werden, wobei die auf hoher Rückbildungsstufe entweichenden Gase die Luft, in welcher sie ihre weitere Rückbildung erfahren, mit Gestank und Miasmen erfüllen.

Bedenken wir nun, welche Einwirkung das Leben in solcher Luft, die wir stets einathmen und mit unseren Nahrungsmitteln verschlucken, die unsere Sinne stets empfinden, auf unsern Organismus haben muß, so ist es nicht zu verwundern, wenn auf direkte oder indirekte Weise Krankheiten entstehen, wie sie unter solchen Verhältnissen in der That auftreten, als: Wechselfieber, Cholera und gelbes Fieber. Es bedarf also zur Entstehung dieser großen Uebel nur der Wasserarmuth und hoher Temperatur.

Durch das Sinken des allgemeinen Niveau's treten große Flächen organischer Körper zu Tage und verbreiten durch ihren Uebergang vom Fäulniß- zum Verwesungsprozesse die übelsten und schädlichsten Dünste. Deshalb stinken Möser, Sümpfe, Altwässer, Flußufer und Abzugskanäle, wenn ihre Niveaux sinken; daher erklärt es sich auch, warum die Cholera fast immer in den Niederungen tropischer Länder entsteht, nach dem Laufe der Flüsse sich verbreitet, und besonders in großen Städten Station macht.

In diesen Niederungen nämlich ist die Temperatur hoch genug, um solch' verderbliche Umsetzungsprodukte der zu Tage getretenen organischen Schichten zu erzeugen; in den über Wasser getretenen vegetationslosen Flußufern wird leicht unter gleichen Verhältnissen derselbe Prozeß eingeleitet und nach dem Laufe derselben fortgeführt; in großen Städten endlich liegen bei dem gegenwärtigen Kloaken- und Kanalsysteme eine so große Menge organischer Abfalls- und Auswurfstoffe zu Tage, daß man sich über ihre schädlichen Einwirkungen unter den angegebenen Verhältnissen nicht wundern kann.

Den Beweis für die Richtigkeit dieser Anschauungen liefert die Natur selbst, wenn wir die Mittel in's Auge fassen, wodurch sie Abhülfe von diesen Uebeln schafft.

Diese Abhülfe nun wird uns entweder durch den Eintritt von Regen oder kälterer Jahreszeit.

Die Wirkung beider Ereignisse besteht darin, daß sie durch Hinwegnahme eines oder zweier Verwesungsfaktoren: der hohen Temperatur oder der Luft, den Rückbildungsprozeß der organischen Stoffe vom Wege der Verwesung auf den der Fäulniß zurückführt.

Durch den Eintritt von Regen werden die Dünste niedergeschlagen, die Temperatur abgekühlt, und die zu Tage getretenen Schichten organischer Stoffe wieder unter Wasser gesetzt. Der Eintritt kälterer Jahreszeit wirkt durch Verminderung des Temperaturgrades. Auch das Steigen des allgemeinen

Niveau's, herrührend von Niederschlägen, welche in unserm Stromgebiete stattgefunden haben, kann uns auf gleiche Weise Abhülfe bringen. Es steigen dann die Flüsse und die Quellen fließen reicher. Der Erfolg ist derselbe: Unterwassersetzung, Abkühlung, Auswaschung der Kanäle, mit einem Wort Rückführung auf den Fäulnißweg.

Beispiele werden vorstehende Behauptungen erläutern und erhärten.

Die Cholera entsteht, wie oben gezeigt, in der Regel in den Niederungen tropischer Gegenden, weil dort die Temperatur hoch und andauernd genug ist, um so verderbliche Verwesungsprodukte zu erzeugen. Ihre Verbreitung folgt dem Laufe der Flüsse, dem Saum der Gewässer, überschreitet aber den 60. Breitengrad in der Regel nicht, weil in jenen Ländern der Wasserreichthum zu groß, oder die Temperatur nicht hoch oder andauernd genug ist zu ihrer Entstehung oder Ausbildung.

Wenn wir daher von der Cholera oder der heftigeren Malaria weniger belästigt werden als andere südlichere Gegenden, so liegt der Grund hievon darin, daß wir einen größeren Wasserreichthum, niedrigere Temperatur und bleibende Vegetation während der heißen Jahreszeit haben, welch' letztere die Einwirkung der Hitze auf den Boden durch Deckung vermindert und die Produkte der Umsetzungen desselben absorbirt; keineswegs aber darin, daß bei uns die Stoffe nicht gegeben wären, aus welchen sich bei gleichen sonstigen Verhältnissen diese Seuchen entwickeln könnten. Die Bestandtheile unseres Bodens und unserer Abfälle werden sich von denen jener Gegenden in nichts Wesentlichem unterscheiden. Wie die tropische Sonne aus denselben Grundstoffen andere Gebilde, Farben, Gerüche als bei uns erzeugt, ebenso wird sie aus denselben Leichen andere Umsetzungsprodukte der Verwesung hervorgehen lassen. Es gibt demnach nur der Unterschied der Temperatur und des Wasserreichthums den Ausschlag.

London hatte während der heißen Junitage (1. bis 19. 1858) einen Choleratodesfall bei einem Kloakenarbeiter, dessen

Ursache sich nur auf die Ausdünstungen, in denen er arbeiten mußte, beziehen ließ. Dieser Todesfall beweist daher die lokale Entstehung des Seuche-Miasma's.

Die Themse verbreitete damals einen so heftigen Gestank, daß man ihre Nähe floh. Bezüglich desselben glaube ich jedoch, daß ihn nicht so fast die Themse als solche verursachte, sondern vielmehr die blosliegenden Flußufer und Zuzugskanäle, welche durch die andauernde Trockenheit und die jeweilige Ebbe eine große Menge Dejektionsstoffe zu Tage treten ließen. Gleichwohl ist nicht zu verkennen, daß die Themse nach ihrer Sättigung mit Umsetzungsprodukten, welche bei ihrem niedern Wasserstande um so früher eintreten mußte, daß sie bei der steten Bewegung ihrer Massen, eine große Menge Fäulnißgase in die Luft entweichen ließ, welche durch ihre Concentration äußerst unangenehm und zugleich schädlich einwirken mußten.

Dieses große Uebel nun, gegen welches alle Maßregeln vergeblich ergriffen wurden, hörte auf, sobald Regen eingetreten war.

Die Cholera, welche 1854 München so schwer heimsuchte, war fort und fort (vom Juni bis Ende September) vom schönsten Wetter begleitet. Als die kühlere Jahreszeit, Ende September, mit einigen Niederschlägen eingetreten war, hörte die Quelle der Seuche auf und man hatte es nur mehr mit ihren Ausläufern zu thun.

Der Vergleich der Jahre 1859 und 1860 ist in dieser Beziehung lehrreich. 59 war (vom Juni angefangen) arm, 60 reich an Niederschlägen; 59 reich an Wärme und Sonnenschein, 60 arm daran. 59 war die Cholera auch in unseren Gegenden nahe, indem Cholerine bereits aufgetreten war, 60 vollständig frei davon. Wenn es im Jahre 59 nicht zum Ausbruche der Cholera kam, so verdanken wir dieß theils den reichen Niederschlägen des Frühjahres, also dem guten hohen Wasserstande, theils dem noch rechtzeitigen Eintritte von Niederschlägen in den Sommermonaten, also der Verbesserung des bereits tief gefallenen Wasserstandes.

An einem viele Quadratklafter großen, mit Steinen ausgesetzten Wasserbecken waren obige Momente genau zu beobachten. Vom Eintritte des dauernd schönen Wetters bis zum Ausbruche der Cholerine war das Niveau dieses Beckens um 8—10′ gefallen. So lange der schlammige Boden desselben noch mit Wasser bedeckt war, konnte man sich unbelästigt in dessen Nähe aufhalten; als aber sein Boden zu Tage zu treten anfing, war die Ausdünstung desselben eine sehr starke, möselnde, welche beim leisesten Luftzuge eine unerträgliche, Brechreiz erzeugende wurde. Nach eingetretenem Regen, nach wiedererfolgter Ueberdeckung des Bodens mit Wasser, also nach Unterwassersetzung der organischen Schichten, nach Rückführung vom Verwesungs- auf den Fäulnißweg hörten obige Einwirkungen gänzlich auf.

Sümpfe und Möser hören auf, Gestank zu verbreiten, sobald ihre Wasser steigen, sobald sonst unter Wasser befindliche zu Tage getretene Erdschichten wieder unter Wasser gesetzt sind.

Dasselbe Verhältniß zeigt sich bei Kloaken und Abfallsgeschirren; wird ihr Inhalt oder ihre schmutzigen Wandungen unter Wasser gesetzt, werden sie mit Wasser angefüllt, so hört der Gestank auf.

Den Weg nun, welchen die Natur geht, um diese Uebel zu beseitigen, müssen auch wir — sie nachahmend — zu gleichem Zwecke einschlagen und jene Momente herbeizuführen suchen, unter welchen wir gesunde Luft haben.

Gesunde Luft aber weht:

„auf dem Wasser, auf vegetirenden oder vollständig
„trockenen Flächen.“

Hieraus ergibt sich nun die Aufgabe: den Verwesungsprozeß, welcher als die Quelle dieser Uebel angesehen werden muß, möglichst zu verhindern; die Vegetation, diesen Regulator unserer Luft, möglichst zu begünstigen und die Herstellung vollständiger Austrocknung feuchter, unfruchtbarer Flächen möglichst zu unterstützen. Ersteres wird erreicht durch Unterwasserhaltung oder Begrabung der organischen Stoffe; das

Zweite durch Gewinnung der Abfälle und Auswurfsstoffe, durch hiemit erzielbare Hebung der Kultur; das Letzte durch Wasserabfluß — durch horizontale oder vertikale Röhren und Sand (Stein); Drainage — oder Auffüllung, Ueberdeckung mit Erde oder Sand.

II.

Wichtigkeit und Nothwendigkeit der Stoffgewinnung.

Von nicht geringerem Belange als die Desinfection für die Sanitäts-Verhältnisse ist die Stoffgewinnung für die Oeconomie, deren Blüthe wieder nur ein Mittel für gute Sanitäts-Verhältnisse ist, so daß sich die Stoffgewinnung indirect ebenfalls auf die Sanität bezieht.

Die Producte der Oeconomie, als: Fleisch, Körner, Futter rc. wandern zum größten Theil in die Städte; von hier aus durch die Organismen der Menschen und Thiere in die Aborte (Kanäle) und auf die Miststätten. Während nun die Stoffe letzterer Richtung für unsern ferneren Lebensunterhalt gerettet sind, gehen die der ersteren häufig verloren, wenn auch nicht absolut, so doch relativ, local verloren. Dieß geschieht besonders in großen Städten, wo man schon genug gethan zu haben glaubt, wenn man durch Abzugskanäle für die Fortschaffung der Abfälle in Flüsse Sorge getragen hat. Daß man aber durch dieses Reinigungssystem nicht einmal den directen Anforderungen der Sanität: Vermeidung übler und schädlicher Ausdünstungen, genügt, beweist das Verhalten der Themse, geschweige denn ihren indirecten, denen der Oeconomie: Erhaltung der Circulationsstoffe des Lebens.

Wenn die Abfälle der Städte nur zum Theile erhalten und dem Boden, aus dem sie in Form von Früchten entnommen sind, wieder einverleibt werden, so muß sich das Kapital desselben verringern, stetig verringern, muß zuletzt erschöpft werden. Daß letzterer Zustand bei vielen Feldern bereits eingetreten ist, ergibt sich aus der Nothwendigkeit der Zufuhr fremden Düngstoffes, des Guano; ergibt sich aus der

Blüthe dieses Handels. Sind dann die Felder hiedurch wieder zur Tragfähigkeit gebracht, so wandern ihre Früchte und damit auch die zugeführten Stoffe wieder in die Städte, in die Kanäle und fort in die Flüsse, und das Bodendeficit muß durch neue Zufuhr gedeckt werden. Wäre nun am Zeit- und Geldaufwande, welcher hiefür gemacht werden muß, nichts gelegen, wären die Guanovorräthe unerschöpflich, so könnte man diese schlechte Wirthschaft, wobei wir in der Ferne kaufen, was wir zu Hause ebenfalls und wohlfeiler haben könnten, fortsetzen. Allein es wird eine Zeit kommen, wo diese Vorräthe in unsern Flüssen und Meeren oder im besten Falle an fernen Ufern als angeschwemmtes Land liegen, von woher wir sie wieder als Früchte oder Düngstoffe um theures Geld beziehen müssen. Dieser Zeitpunkt wird dann freilich auch die Nothwendigkeit der Stoffgewinnung nicht allein in öconomischer, sondern auch in sanitätischer Beziehung, wenn nämlich die Folgen mangelhafter und schlechter Nahrungsmittel eintreten, zur allgemeinen Anerkennung bringen. Es ist eine gerechte Anforderung der Sanität, gute und zureichende Nahrungsmittel zu verlangen. Quantität und Qualität derselben aber hängen von der Beschaffenheit des Bodens, diese von der Wiedereinbringung der als Früchte ausgeführten Bodenbestandtheile ab. Geschieht dieß nicht, werden nicht wenigstens die Aschenbestandtheile der ausgeführten Früchte wieder einverleibt, so wird der Boden zuletzt im günstigsten Falle nur mehr Früchte tragen, deren Bestandtheile er sich aus der Luft, dem Regenwasser und den unerschöpflich vorhandenen, den einseitig vorwiegenden Bodenbestandtheilen holen kann. „Wie aber der Boden, so wird seine Bevölkerung sein."

Leicht begreiflich geht hieraus die unabweisbare Nothwendigkeit hervor, ein Reinigungs-System aufzugeben, welches vor Infection nicht nur nicht schützt, sondern sie durch Flächenausdehnung sogar begünstigt und überdieß die Nahrungsmittel der Zukunft unaufhörlich fortführt.

(Ausführlich diesen Gegenstand behandelt siehe: Liebig's chemische Briefe, Allgemeine Zeitung 1857).

III.

Mittel zur Desinfection und Stoffgewinnung.

All' dieß nun: Vermeidung des Gestankes und der Infection, Erhaltung der Abfalls- und Auswurfsstoffe, läßt sich erzielen: A. im Kleinen: durch Anlage und entsprechende Construction der Dejections-Instrumente; B. im Großen: durch entsprechende Behandlung der Möser, Sümpfe, Kanäle rc.

A.

1.

Alle Abfälle und Auswurfsstoffe der Menschen und Thiere, der Gewerbe und Straßen müssen fernerhin gesammelt und vor den Verwesungsfactoren: der hohen Temperatur und Luft, durch Deckung, durch Unterwasserhaltung oder Begrabung geschützt werden.

Zu diesem Zwecke dürfen die Abtritte nicht mehr in Kanäle oder Bäche, sondern müssen in Sammelgruben münden. Die Stühle abtrittloser Häuser und die Straßenabfälle müssen in eigens zu diesem Zwecke angelegte allgemeine (Districts-) Gruben geschüttet werden.

In die Kanäle und Bäche gelangen nur mehr das Regen- und Schnee-, das geseihte Wasch- und Spülwasser; die abgefaulten Grubenflüssigkeiten werden erst filtrirt und dann in Versitzgruben oder auf den Grund von Bächen, Kanälen und Flüssen geleitet.

2.

Die Sammelgruben (Sammelgefäße) sollen, was bei neuen leicht ausführbar ist, aus undurchlassendem Material erbaut werden. Schon bestehende Gruben sind fortzugebrauchen, denn diese haben durch Beschlagung der Wandungen und des umgebenden Terrains mit unlöslichen Stoffen eine undurchlassende Schichte um sich gebildet.

3.

Die Ableitung der Grubenflüssigkeiten, wenn sie eine gewisse Höhe, etwa 3—4″ zum Rande der Grube erreicht

haben, geschehe zur Vermeidung des Ueberlaufens derselben mit allen seinen nachtheiligen Folgen und zur Entfernung des Wassers nach vorhergegangener Filtration durch eine heberartig oder mittelst Gravitation wirkende Röhre.

4.

Die Construction der als permanenter Heber wirkenden Röhre besteht darin, daß die Mündungen derselben aufwärts gebogen in der gleichen horizontalen Ebene liegen, während ihr Mittelstück beliebig — nicht über 25′ aufwärts — verlaufen kann. (Figur Nr. 1.) Ist eine derartig construirte Röhre einmal mit Flüssigkeit angefüllt, so wird sie — dieselbe Lage beibehaltend — nicht mehr leer, und wirkt leitend, so oft ein Ende derselben unter ein höheres Niveau kommt — und so lange, bis der gleiche Niveaustand mit dem anderen Ende herbeigeführt ist. Eine solche Röhre würde also die Flüssigkeit aus der Grube herausheben und zu einem beliebigen Abflußpunkte: auf den Grund der Kanäle, des Flusses oder der Versitzgrube fortführen, wodurch das Entweichen der Gase unmöglich würde.

5.

Die Filtration der Grubenflüssigkeiten könnte auf verschiedene Weise innerhalb oder außerhalb der Grube vorgenommen werden. Bei der Filtration innerhalb der Grube stelle man ein Gefäß in dieselbe, welches vom Boden der Grube bis zu ihrem Rande reicht. Dieses Gefäß, aus Holz oder entsprechendem Metall gefertigt, klein (schmal), bis zu einem Drittel von Oben nach Unten mit einem es überragenden Ringschirm bedeckt, um nur die tiefern, schon abgefaulten Flüssigkeitsschichten zum Abflusse gelangen zu lassen, wird mit Kohle (und Erde) gefüllt und aus seinem Grunde erhebt sich eine kleine Röhre, durch welche die filtrirte Flüssigkeit zur Ableitungsröhre emporsteigt. (Fig. 2.)

Bei der Filtration außerhalb der Grube wird in einiger Entfernung von derselben eine neue Grube gebaut, welche als Filtrir- und Versitzgrube zugleich dient. In diese Grube, welche leicht so tief angelegt werden kann, daß der Anblick derselben durch einen Deckel vermieden, und daß an Terrain nichts für den sonstigen Gebrauch verloren geht, stellt man ein Filtrirgefäß mit obiger Füllung, und läßt die aus der Grube herüber geleitete Flüssigkeit durch die kleine Röhre zuerst auf den Grund des Gefäßes gelangen, durch die Filtrirmasse emporsteigen und über den Rand des Gefäßes zum Boden der Versitzgrube abfließen.

Um aber eine Ueberführung von aufgeschwemmten, unlöslichen Stoffen aus der Sammelgrube zum Filtrirgefäße und dadurch eine mögliche Verstopfung der Filtrirmasse zu vermeiden, muß das Grubenende der Leitungsröhre aus einer kleinen Filtrirvorrichtung, — Seihevorrichtung — etwa einem Kohlencylinder, aus einem Filter von plastischer Kohle entspringen. (Fig. 3.)

Eine andere Ableitungsmethode der Grubenflüssigkeiten, falls die Filtration zu theuer oder zu umständlich befunden würde, wäre die Ableitung derselben nach Fig. 3 mit Veränderung von B. Hiebei ließe man die Grubenflüssigkeiten von A aus sogleich auf den Grund der Versitzgrube gelangen. (Fig. 4.)

Anstatt aber eine eigene Grube hiefür zu erbauen, würde man nur bis zu einer durchlassenden Bodenschichte ein Loch graben, den Grund dieser Vertiefung gegen Verschüttung durch Einsturz mittelst Einsetzung einer Querdeckung schützen und aus der Nähe des Grundes eine Röhre, durch welche die Zuleitung geschähe, emporsteigen lassen und den über der Querdeckung gelegenen Raum wieder ausfüllen. (Fig. 4 B.)

6.

Für die Dejektionen abtrittloser Häuser und für die Abfälle der Straßen ꝛc. müßten an entsprechenden Punkten eigene Gruben erbaut werden, wenn man es nicht etwa vorzieht, letztere Stoffe einmal aufgeladen sogleich an ihren Bestimmungsort (Guanofabrik) zu bringen und die Arbeit der Umladung zu ersparen.

Die Anlage solcher Commungruben könnte in Hofräumen oder im Erdgeschoße rückwärts gelegener Gebäude, welche eine

Einfahrt haben, vorgenommen werden. Ihr Raum müßte durch geeignete Baulichkeiten abgesperrt und die Gruben selbst durch einen Deckel (hermetisch) geschlossen werden. (Fig. 5.)

7.

Gruben von dieser Construktion würden allen Anforderungen der Desinfektion und Stoffgewinnung genügen. Es dürfte Alles, was Abfall heißt, in sie gelangen; ihre Stoffe wären, da die flüssigen Dejektionen die festen an Quantität bei weitem übertreffen, stets unter einer absperrenden Flüssigkeitsschichte, somit vor den Einflüssen der Temperaturunterschiede und vor der Einwirkung der Luft geschützt, weil ja die Erwärmung der Flüssigkeit — von der Bedeckung derselben ganz abgesehen — von Oben nach Unten eine kaum nennenswerthe ist, und in geringer Tiefe ganz aufhört und weil der Einwirkung der Luft nur die eine glatte Oberfläche dargeboten würde, während das ganze übrige Stoffvolumen davor geschützt bliebe.

„Die Rückbildung der Stoffe wäre daher nur auf „dem Wege der Fäulniß möglich, wodurch Infektion „vermieden und sich eine Menge unlöslicher Körper „bilden und niederschlagen würden; selbst viele lösliche „würden wegen überschrittener Sättigungscapacität der „Flüssigkeit niederfallen.“

Ein übler Einfluß von solchen Gruben auf das umgebende Terrain durch Ueberlaufen oder Versickern der Stoffe wäre nicht zu befürchten, weil Ersteres wegen gegebenen steten Abflusses nicht möglich wäre, Letzteres aber durch das undurchlassende Material der Grube oder die gebildete undurchlassende Schichte verhindert würde.

„Wenn manche Brunnen dennoch nach solchen De„jektionsstoffen riechen oder schmecken, so rührt dieß „davon her, daß sie mit Kloaken oder Gruben in di„rekter — offener — Verbindung stehen, oder daß die „fraglichen Stoffe von Oben hineinlaufen; durch Zu„sickerung von Sammelgruben aus kann es nicht ge-

„schehen, denn das dazwischen gelegene Erdreich dient als „Filtrum, welches weder die löslichen noch unlöslichen „Stoffe durchlaufen läßt." (Liebig's chemische Briefe.)

Wäre dieß nicht so, dann würde es kaum einen Stadtbrunnen mit genießbarem Wasser geben.

Aus gleichem Grunde ist von der abgeleiteten Flüssigkeit, von den Versitzgruben aus nichts zu befürchten, abgesehen davon, daß die Stoffe vor dem Versickern schon ein Filtrum passirt haben.

Da nun in Beziehung auf Sanität von der Sammlung der Stoffe in Gruben und von der Ableitung der abgefaulten Grubenflüssigkeiten in Versitzgruben — von ihrer Begrabung — nichts Uebles zu befürchten ist, so ist die letztere Maßnahme nur noch hinsichtlich der Oeconomie, des Stoffverlustes näher in's Auge zu fassen.

8.

Die Dungstoffe theilen sich in flüchtige und fixe; letztere in aschengebende und in solche, welche bei ihrer Verbrennung keine Asche zurücklassen.

Der Verlust aller flüchtigen Düngstoffe ist nur ein scheinbarer, indem sie von den Pflanzen aus der Luft, dem Boden, der sie einsaugt, und dem Regenwasser, mit dem sie niedergeschlagen werden, geholt und wieder in den organischen Kreislauf zurückgeführt werden. Ebenso verhält es sich mit den Stoffen, welche beim Verbrennen keine Asche zurücklassen, sie bestehen nur aus Verbindungen, welche wir uns als Wasser und Luft mit ihren Beimengungen zusammengesetzt denken können, als: Kohlensäure, Ammoniak, Schwefel- und Phosphor-Wasserstoff. Alle Stoffe, welche nur aus Sauer-, Wasser-, Kohlen- und Stickstoff zusammengesetzt sind, können wir verflüchtigen und verrinnen lassen, ohne dabei einen wirklichen Verlust zu erleiden. Und es ist gut, daß es sich so verhält, denn hätten die Menschen für die Wiedereinbringung auch dieser Stoffe in den Boden zu sorgen, — so brauchten sie dieß schon lange nicht mehr zu thun, die Welt hätte längst aufgehört zu vegetiren.

Unabweislich nothwendig aber ist die Erhaltung und Wiedereinbringung der Aschenbestandtheile der Abfallsstoffe: der Alkalien und alkalischen Erden, der Phosphor- und Schwefelverbindungen. Gehen auch durch die Ableitung der Flüssigkeiten einige alkalische Stoffe verloren, so wird doch der bei weitem größere und wichtigere Theil derselben gerettet. Am Verluste von schwefel-, kohlen- und salzsauren Alkalien und Erden ist wenig gelegen, weil sie im Ermanglungsfalle dem Boden leicht durch mineralische Düngung gegeben werden können, die schwerer beizuschaffenden, die phosphorsauren Salze aber werden durch den Fäulnißprozeß, indem sich phosphorsaure Ammoniak-Magnesia, oder basisch-phosphorsaure Verbindungen bilden, unlöslich und somit gerettet. Ein Bild, woran wir sehen können, wofür wir zu sorgen haben und was ohne unser Zuthun geschieht, gewährt das Holz: geben wir den Wäldern die Rückstände unserer Oefen zurück; für das, was durch den Schlot fortgeht, sorgen sie selbst durch die Luft.

9.

Eine Unwirksamkeit der Versitzgruben durch Beschlagung ihrer Wandungen mit lehmartigen, undurchlassenden Stoffen, wie dieß bei Versitzgruben, wohinein Alles, Lösliches und Unlösliches, gelangt, der Fall ist, wäre nicht zu befürchten, weil nur lösbliche Stoffe in sie gelangen, indem die aufgeschwemmten Stoffe vom Filtrum zurückgehalten würden. Besonders wirksam dürfte sich die Versitzgrube (Fig. 4) erweisen, weil bei der Zunahme der Flüssigkeit und dem Steigen derselben in der Zufuhrsröhre ein Druck auf die Grubenwandungen entstünde, der sich nach dem Gesetze der hydraulischen Presse berechnet, weil somit das Versickern der Flüssigkeit nicht auf die Schwerpunktsrichtung allein, welche durch etwaige Ablagerungen versperrt werden könnte, angewiesen wäre, sondern in allen Richtungen der Kugel erfolgen müßte.

10.

Ein wesentlicher Vortheil dieser Gruben bestünde darin, daß ferner das größte und voluminöseste Hinderniß der Stoffgewinnung, das Wasser, entfernt würde.

Der Harn, welcher die Hauptmasse der flüssigen Abfälle ist, besteht aus 90 pCt. Wasser. Ein ähnliches Verhältniß besteht zwischen der Summe aller festen und aller flüssigen Abfälle, so daß bei Gewinnung aller Abfälle durch das angedeutete Grubensystem doch eine Arbeitsverminderung eintreten würde, welche sich verhielte, wie 10 zu 1.

Die Räumung dieser Gruben wäre erst nothwendig, wenn sie mit festen Stoffen angefüllt wären, welcher Zustand aber im gleichen Verhältniß später erfolgen müßte. Die Räumung derselben könnte somit, was nur alle zwei, höchstens alle Jahre einmal nothwendig wäre, immer zur guten — kalten — Jahreszeit und mit Geschirren kleinerer Dimensionen vorgenommen werden.

11.

Ein anderer Weg zur Desinfection und Stoffgewinnung wäre geboten durch Benützung des dritten Factors gesunder Luft: der Dürre, indem die festen Stoffe durch Drainage der Gruben von den flüssigen getrennt, somit stets trocken gehalten, die flüssigen aber in Versitzgruben abgeleitet würden, aus welchen man die werthvollen Fäulnißproducte, welche sich am Boden ablagerten, während das Wasser bei Zunahme und dem Steigen der Flüssigkeit in der Zuflußröhre, wie oben gezeigt, nach der Richtung der Radien einer Kugel versickern würde, durch Räumen oder Ausbaggern gewänne. (Fig. 6.)

12.

Um das Eindringen der Grubengase in die Häuser und Wohnungen bei Grubenräumungen oder beim Eintritte schlechten Wetters — verminderten Luftdruckes, Fallen des Barometers — zu verhindern, sollten die Abtrittröhren nicht direct in die Gruben münden. Die Vermeidung dieses Uebelstandes ist möglich, wenn man die Abtrittröhren in entsprechend große, mit Wasser angefüllte Gefäße münden läßt, welche an der

Röhre selbst in der Art beweglich aufgehängt werden, daß sie von der letzten Etage aus geöffnet und geschlossen werden können. (Fig. 7.)

Hiedurch würde ein steter, hermetischer Abschluß von der Grube gegeben, ohne daß die Dejectionen im Mindesten beeinträchtigt würden, indem sowohl die flüssigen als festen Stoffe bei neuem Nachschube unter der Röhre durchtreten und zuletzt über den Rand des Gefäßes fallen müßten, oder bei eintretender Schoppung durch die gegebene Beweglichkeit der Schüssel entleert werden könnten. Ein übler Einfluß von Seiten der in diesen Gefäßen befindlichen Stoffe wäre nicht möglich, weil sie stets unter Wasser wären und auch sonst nicht so lange darin verweilen würden, als zu ihrer Umbildung nothwendig wäre.

Münden Abtritte ohne solche Leitungsröhren in die Gruben, so soll man zur Zeit der Grubenräumung nasse Tücher auf die Oeffnungen legen und die Deckel zur Absperrung fest aufdrücken.

13.

Für Häuser oder Wohnungen ohne Abtritte, für Kranken- und Schlafzimmer ist die Einführung geruchloser Nachtstühle ein Bedürfniß, welches die vollste Berechtigung auf Befriedigung hat und mit dessen Befriedigung man schon lange bemüht ist.

Der Verfasser glaubt die Construction eines solchen gefunden zu haben und theilt sie im Nachfolgenden mit.

Der geruchlose Nachtstuhl besteht aus vier Theilen, wovon der erste zur Aufnahme der Stoffe, der zweite zur Leitung und Deckung derselben, der dritte zur Deckung der Leitungsröhre und der vierte zum Entweichen der Luft und Gase dient.

Der erste Theil ist ein Gefäß, am besten wohl aus Bleiblech gefertigt, dessen Rand mittelst Anlöthung eines Blechstreifens eine Rinne bildet. (Fig. 8. a.)

Der zweite besteht aus einem Blechdeckel, dessen Rand abwärts gebogen ist und in die Rinne des ersten einpaßt;

an einem Puncte seiner Krümmung (Fig. 8 b.) befindet sich eine kleine Luftröhre eingelöthet; in seiner Mitte befindet sich die ovale Leitungsröhre, welche den Deckel, der sich gegen dieselbe zu senken — eine Rinne bilden muß, überragt und bis auf etwa 2" zum Boden des Gefäßes reicht. (Fig. 8 c.)

Der dritte Theil ist ein Blechdeckel mit einer Handhabe, welcher den Rand der ovalen Röhre leicht umschließt. (Fig. 8 d.)

Der vierte endlich ist eine Gutta-Percharöhre, welche die Luftröhre des zweiten Theiles umschließt und den Austritt der Luft und Gase bei Zunahme der Stoffe im Gefäße in einen Kamin oder Hofraum 2c. gestattet.

Zwischen den ersten und zweiten Theil könnte zur Aufnahme der Stoffe auch ein anderes Gefäß (aus Holz, Porzellan oder Glas gefertigt) eingesetzt werden.

Wird nun in die Rinne des ersten und in die Deckelvertiefung des zweiten Theiles Wasser geschüttet, so ist der Inhalt des Nachtstuhls hermetisch abgeschlossen, daher die Geruchlosigkeit erzielt.

Der Einfluß von den Stoffen der ovalen Röhre wäre ein kaum nennenswerther, indem die älteren sich im Wasser befinden, die neueren sogleich darein gelangen würden und ihre Einwirkung nie länger dauern könnte, als die eben stattfindende Dejection.

Ist die Leerung eines solchen Stuhles geschehen, so werde er so hoch mit Wasser angefüllt, daß die ovale Röhre des Deckels in dasselbe eintaucht, damit die Ausdünstungen der Gefäßwandungen bei neuen Dejectionen nicht durch dieselbe entweichen können.

Diese Nachtstühle könnten in allen Größen gefertigt werden und hätten außer der Wohlfeilheit noch den weiteren Vortheil, daß sie nicht täglich, nicht so oft geleert zu werden brauchen.

14.

Gefäße von ähnlicher Construction, wie der eben angegebene geruchlose Nachtstuhl, würden sich zur Aufstellung im Pißlocalitäten eignen, um hiedurch sowohl die Verwesung

der sonst liegenbleibenden Stoffe als auch die Verdünstungsfläche für Ammoniak zu verringern.

In größern Etablissements: in Spitälern, Kasernen, Bahnhöfen 2c. ist der Eindruck dieser Localitäten auf den Gesichts- und Geruchssinn, auf die Lungen und ein etwa geschwächtes Nervensystem überhaupt ein so großer, unangenehmer und oft schädlicher, daß die Beseitigung dieses Zustandes mehr als wünschenswerth wird. Um ein Ueberlaufen dieser Gefäße und um zugleich Arbeitsverminderung überhaupt zu erzielen, müssen sie mit Ableitungsröhren versehen werden, welche nach Einrichtung und Wirkungsweise mit den Ableitungsröhren der Gruben gleich sein könnten. (Fig. 9.)

Die Entleerung dieser Gefäße, wenn sie mit Fäulnißproducten des Urins angefüllt sind, geschieht in die Sammelgrube; sie ist nur selten nöthig und leicht zu vollführen.

Durch ähnliche Vorrichtungen sollten die festen Bestandtheile — die unlöslichen Fäulnißproducte des Urins unserer Hausthiere, der Niederschlag aus der Jauche der untermauerten Dungstätten und die unlöslichen Stoffe des Wasch- und Spülwassers gewonnen werden.

Zu diesem Zwecke stelle man an einem Puncte inner- oder außerhalb des Stalls ein Gefäß auf, oder erbaue eine Grube, welche den fünffachen Betrag des täglichen Abfalls aufzunehmen im Stande ist, und leite, wie bei den Gruben angegeben, die abgefaulten Flüssigkeiten ab. Hiedurch würde dem Urin Zeit gegeben, abzufaulen — seine werthvollen Phosphorverbindungen fallen zu lassen. In Anbetracht der Fermentwirkung der faulenden Stoffe auf den frisch zufließenden Urin würde ein Behältniß von fünffacher Aufnahmsfähigkeit der täglichen Ausscheidung genügen.

Für Wasch- und Spülwasser sollten in den Stockwerken zur Arbeitsverminderung und Kraftersparung der Dienenden Gefäße aufgestellt werden, wodurch die festen Stoffe gewonnen, und wenn Füllung eingetreten, in die Gruben geschüttet, die flüssigen aber von selbst durch Röhren an entsprechende Puncte abgeleitet würden. (Fig. 10.)

15.

Ist die Räumung der Sammelgrube nothwendig, weil sie mit festen Stoffen vollgefüllt ist, so werde zuerst die noch vorhandene Grubenflüssigkeit in ein Gefäß herausgeschöpft, die festen Stoffe dann ebenfalls in Gefäße herausgeschlagen, aus welchen unten die eingeschlossene Flüssigkeit anfangs von selbst, zuletzt durch Pressung zur Volums- und Gewichtsverminderung abfließen kann. Nach Vollendung der Arbeit werden die Transportgefäße, welche zur Vermeidung des üblen Geruches auf ihren Wegen von ähnlicher Construction, wie die geruchlosen Nachtstühle sein könnten, bedeckt, die ausgeschöpfte und ausgepreßte Flüssigkeit wieder in die Grube geschüttet, letztere ebenfalls bedeckt und die Sammlung der Stoffe von Neuem begonnen.

Die Wandungen der Gruben würden unter den angegebenen Verhältnissen bei kühler Temparatur und guter Bedeckung kaum einen nennenswerthen Geruch verbreiten, der, um schädlich zu sein, nicht concentrirt genug wäre und überdieß durch Eintrocknung — Dürre — der adhärirenden Stoffe bald ganz aufhören müßte.

Sind die gewonnenen Stoffe an ihrem Verarbeitungsorte — Guanofabrik — angelangt, so könnten sie zur vollständigen Entfernung des Wassers auf eine durchlassende Unterlage — Kohlenbett — geworfen, später in entsprechende Formen gepreßt und in geeigneten Gebäulichkeiten bis zu ihrer Verwerthung aufgestellt werden.

16.

Ist die Räumung einer Versitzgrube wegen Niederschlages aus der Flüssigkeit nöthig, oder will man überhaupt aus einer Flüssigkeit den Bodenbeschlag herausnehmen — ausbaggern — so würde dieß leicht auf folgende Weise geschehen: Man nimmt einen entsprechend geformten, langen Stechheber, welcher unten schief abgeschnitten ist und oben durch einen Hahn gesperrt werden kann. Diesen nun setzt man mit geschlossenem Hahn in die zu entleerende Masse ein und öffnet dann den

Hahn, wodurch vermöge des Wasserdruckes die Stoffe bis zum Wasserniveau im Heber emporgedrückt werden. Hierauf wird der gefüllte Heber nach Absperrung des Hahnes entfernt und die herausgeholten Stoffe auf eine durchlassende Unterlage gebracht. (Fig. 11.)

17.

Im Falle aber die vorbeschriebenen Stoffgewinnungs-Vorrichtungen und Arbeiten zu umständlich und zu theuer befunden würden, könnten nachfolgende Vorrichtungen, welche sich durch Einfachheit und, wie ich glaube, durch Zweckdienlichkeit auszeichnen dürften, Anwendung finden.

Diese Vorrichtungen theilen sich je nach der Absicht der Stoffgewinnung in zwei Abtheilungen:

1) In die Vorrichtungen für locale Gewinnung der Stoffe (im Hause) und
2) in die für commune (Gewinnung der Stoffe in allgemeinen Sammelgruben mit Fortleitung derselben zum Verarbeitungs- oder Verwerthungspunkte in unterirdischen Röhren mittelst Atmosphärendruckes).

ad 1) Der Unterschied zwischen den schon angegebenen und dieser Vorrichtung besteht lediglich in der Hinweglassung der Filtration der flüssigen Abfallsstoffe.

Man verbindet bei dieser Vorrichtung die Sammel- mit der Versitzgrube mittelst einer Röhre, welche in der Höhe, bis zu welcher man die Stoffe steigen lassen will, angebracht ist, und von welcher die festen Stoffe durch Anbringung eines Seihers oder durch Einschiebung oder Umbindung eines Büschel Strohes abgehalten werden. (Fig. 12.)

Die auf dem Grunde der Versitzgrube, — welche zur Verhütung des Einrollens der Wandungen in der Weise ausgemauert sein könnte, daß die Ziegellagen der oberen Hälfte kleine Oeffnungen zwischen sich zum Durchtritte der Flüssigkeiten freilassen, — sich ablagernden Fäulnißproducte der flüssigen, übergeführten Abfallsstoffe werden bei Gelegenheit einer Grubenräumung mittelst des Stechhebers oder durch eine Saugvorrichtung herausgeholt und mitfortgeführt. Hiedurch nun dürften bei gleichem Erfolge die Vorrichtungen einfacher und die Arbeit weniger werden.

ad 2) Für Commungruben, deren Erbauung zur Gewinnung der Abfälle von Häusern, Häusergruppen und ganzer Stadttheile, welche ihre Abfälle jetzt in Bäche und Canäle gelangen lassen, unerläßlich ist, dürfte die nachfolgende Construction, welche sich ebenfalls durch Verminderung der Gewinnungskosten auszeichnete, zweckdienlich sein.

Alle flüssigen und festen Abfälle der Häuser des Grubenbezirks, welche in den geruchlosen Nachtstühlen oder in ähnlich construirten, größeren, auf permanente Transportvorrichtungen gestellten Gefäßen gewonnen werden, gelangen, wie oben gezeigt, in die mit entsprechenden Gebäulichkeiten, Deckeln (und Gasabzugsröhren) versehenen Commungruben, welche zum Unterschiede von den oben erwähnten statt der kleinen Flüssigkeits-Ableitungsröhren mit großen Stoffleitungsröhren versehen sind, wodurch sie mittelst einer gemeinsamen Hauptröhre mit den Vacuums-Vorrichtungen des Verarbeitungspunktes der gewonnenen Stoffe in Verbindung stehen. (Fig. 13.)

Durch diese Röhren, welche 6″ — 1′ weit, verschließbar und am Grunde der Gruben angebracht wären, würde die Zuleitung der Stoffe zum Verarbeitungspuncte, da die flüssigen Theile der Abfälle die festen an Quantität bei weitem übertreffen, mittelst der Saugewirkung einer Dampf- oder Wassermaschine, deren Kraft gleich einer Atmosphäre wäre, in den größten Entfernungen leicht zu bewerkstelligen sein.

Die angegebene (oder noch weitere) Größe der Röhren wäre nöthig, um die Friction der durchgehenden Stoffe möglichst zu verringern; die Verschließbarkeit derselben, um nach Entleerung der Gruben bis auf einen gewissen Punct den Eintritt der Luft, wodurch Unwirksamkeit aller andern Leitungsröhren eintreten würde, durch Sperrung zu vermeiden.

Die Kosten dieser Stoffgewinnungsart, welche bei der anfänglichen Instandsetzung der bezüglichen Instrumente allerdings groß wären, würden in Anbetracht der hiedurch erzielten

fortlaufenden Verminderung der Arbeit, deren Größe als das Haupthinderniß der Stoffgewinnung angesehen werden muß, in Anbetracht der erzielbaren Werthe und der Dauerhaftigkeit der Instrumente als kleine und endlich in Anbetracht der unausbleiblichen Rentabilität als nicht beachtenswerthe zu betrachten sein.

B.

Um die Infection im Großen zu verhindern, ist es nothwendig, daß wir den Mösern, Sümpfen, Flüssen, Altwässern und Canälen die entsprechende Aufmerksamkeit und Bearbeitung angedeihen lassen.

1.

Diese Aufgabe wird gelöst, wenn wir auf besagten Flächen jene Momente herbeiführen, unter welchen wir gesunde Luft haben, diese sind: Wasserreichthum, Vegetation oder Dürre.

2.

Den einen oder den andern dieser Gesundheitsfactoren können wir immer und zwar mit geringen Kosten herbeiführen.

Ist die Herbeiführung einer üppigen Vegetation durch Austrocknung mit nachfolgender Bebauung nicht rechtzeitig oder nicht im entsprechenden Grade — möglich, so trage man Sorge für den Wasserreichthum dieser Flächen, welcher am besten durch rechtzeitige Sperrung des Abflusses mittelst an geeigneten Puncten angebrachter Schleusen und durch Zuleitung von Wasser erzielt wird. Dieselben Mittel eignen sich, um die üblen und schädlichen Ausdünstungen von wasserarmen, halbtrocknen Gräben und Kanälen zu vermeiden.

Wo Stauung nicht möglich ist, wie bei Flüssen, da reinige man ihre Ufer wenigstens in der Nähe der Städte, indem man die zu Tage liegenden Stoffe wegschafft und verwerthet oder sie doch weiter in den Fluß hinein, somit in oder unter Wasser bringt — und vermeide die fernere Verunreinigung derselben.

3.

Die wohlthätige Wirkung der Unterwasserhaltung solcher verwesungsfähiger Flächen durch Sperrung des Abflusses, durch Verhütung halber Austrocknung ergibt sich aus der Wahrnehmung, daß wir in dem wasserreichen Decennium (1840 – 1850) von Seuchen verschont geblieben sind. Die wohlthätige Wirkung des Wasserreichthums erhellt ferner daraus, daß Seen und Flüsse weder Gestank noch Krankheiten verbreiten, welche Wasserarmuth stets im Gefolge haben. Welchen Einfluß die Wandungen und der Grund eines Seebeckens auf die Luft haben würden, wenn das Wasser plötzlich abfließen könnte, ist leicht zu begreifen.

„Venedig würde, wenn das Meer plötzlich zurückträte, durch die Ausdünstungen des Seegrundes unbewohnbar werden.“

Die Unterwasserhaltung durch Schleusenbau würde, abgesehen von ihrem Seuchenschutze und der leichteren, schnelleren und wohlfeileren Zweckerfüllung als durch Trockenlegung die nachfolgende Cultur solcher Flächen begünstigen.

Es gibt in den tropischen Gegenden (Cayenne, Ostindien) Sümpfe, welche während der heißen Jahreszeit die verderblichsten Dünste durch halbe Austrocknung ohne Vegetatian verbreiten. Würden diese, da vollständige Austrocknung aus technischen oder finanziellen Schwierigkeiten nicht möglich ist, durch Verhinderung des Abflusses und Begünstigung des Zuflusses bei einem entsprechenden Wasserstande erhalten, so müßten, indem durch Verdunstung allein das Niveau nicht so tief sinken würde, ihre schädlichen Einflüsse auf die Sanitätsverhältnisse ihrer Umgebung aufhören.

In Bezug auf Cultur wirkte die Stauung noch dadurch begünstigend, daß die Hinwegnahme der Früchte solcher Flächen erschwert, ja verhindert, daß somit das Zuwachsen derselben, das Heben ihres Bodens durch Vegetationsniederschläge beschleunigt würde. Dieser natürlichen oder Selbstcultur verdanken wir unsere Torflager und die Möglichkeit der nutzbringenden künstlichen Cultur.

4.

Die wohlthätige Wirkung der Vegetation, dieses Regulators der Luft, auf die Gesundheitsverhältnisse ist unter vielem Andern an Aegypten zu sehen, welches von seinen Ueberschwemmungen durch die nachfolgende Vegetation nur Segen und keine Nachtheile hat. Bliebe einmal die Vegetation aus, so würde es durch die Ausdünstungen des angeschwemmten Schlammes an großen Uebeln zu leiden haben.

Das Wechselfieber, welches an manchen Orten, wo Neubrüche gemacht oder große Erdarbeiten vorgenommen wurden, entstanden ist, läßt bedeutend nach, ja hört ganz auf, sobald sich die bearbeiteten Flächen mit Vegetation bedeckt haben.

5

Für Flächen, wo Wasserreichthum oder Vegetation entweder nicht möglich oder zweckwidrig ist, wie auf Straßen und Plätzen ꝛc., besorge man vollständige Austrocknung durch Wasserabfluß und Bestreuen mit Sand.

Nachdem nun aus Vorstehendem die Wichtigkeit der Desinfection durch Verhinderung der Verwesung organischer Körper, insbesondere bei hoher Temperatur; die Nothwendigkeit der Stoffgewinnung, der Schließung der Stoffcirculationskette in öconomischer und zugleich in sanitätischer Beziehung; nachdem ferner die Möglichkeit der Realisirung der Desinfection und Stoffgewinnung durch Anwendung der bezeichneten Mittel sich herausstellen dürfte, so wäre nur noch über etwaige Entwürfe und über noch unberührte Nebenwirkungen obiger Maßnahmen zu sprechen.

a. Einwürfe.

Dem Einwurfe, daß die Malaria und die Cholera nicht in den angegebenen Verhältnissen ihren Grund und Ursprung haben, ist durch Beziehung und Beleuchtung der hiebei sich ergebenden Thatsachen zu begegnen.

1.

Da die Malaria und die Cholera immer nur während der warmen und heißen Jahreszeit, im Frühlinge und Sommer auftreten, da ihr Erscheinen mit dem Fallen des allgemeinen Wasserniveau's, mit der relativen Trockenheit der Sümpfe, Möser und Altwässer, mit der Wasserarmuth der Kanäle und Kloaken, mit dem Mangel an atmosphärischen Niederschlägen — mit den daraus sich ergebenden stinkenden Ausdünstungen (den Verwesungsproducten) stets zusammenfallen; da sie bei dem Eintritte der kälteren, dem Verwesungsprozeß weniger günstigen Jahreszeit, oder mit dem Steigen des allgemeinen Niveau's, durch ergiebige Niederschläge immer wieder erlöschen, da sie endlich über gewisse Breitengrade hinaus gar nicht vorkommen: so ist die Behauptung, daß sie mit den verschiedenen Verwesungsproducten in ursächlichem Zusammenhange stehen, wohl eine gerechtfertigte und begründete, so daß man wohl sagen darf, daß sich unter den angegebenen Verhältnissen bei gewöhnlicher Temperatur das Malaria-, bei hoher aber das Choleramiasma entwickelt.

Werden diese Erklärungsmomente auf die Behauptungen angewendet, daß die Cholera und das gelbe Fieber durch Insectenschwärme oder vorausgegangene Epizootieen entstehen, so ergibt sich ein gleiches Resultat.

2.

Insectenschwärme finden während der heißen Jahreszeit statt. Gehen sie aus irgend welcher Ursache zu Grunde, so fallen sie millionenweise zu Boden und unterliegen, wenn sie nicht verbrannt, begraben oder unter Wasser gesetzt werden, dem Verwesungsprocesse mit allen seinen Folgen. Die Insecten als solche, als lebende, bringen uns keine Krankheiten, wohl aber die Momente ihrer Entstehung. Sie werden unter denselben Verhältnissen wie die Miasmen bei relativer Trockenheit und dauernd hoher Temperatur in feuchtem Schlamme ausgebrütet, erzeugt. Ihr Fehlen oder Vorhandensein kann

daher als Maßstab für die Reinheit, Miasmenfreiheit der Luft und umgekehrt benützt werden, so daß die Menge derselben im umgekehrten Verhältnisse zur Reinheit der Luft steht. (Moskitos: Westindien; gelbes Fieber: Insectenmenge in Malariagegenden; Germersheim: Wechselfieber.)

3.

Einer Gelbfieber-Epidemie zu Rio-Janeiro ging nach dem Berichte eines dortigen deutschen Arztes eine Epizootie von Fischen voraus, in Folge derer eine ungeheure Menge Fischleichen an einem Orte, welcher in der damals herrschenden Windrichtung lag, an's Ufer geschwemmt und dem Verwesungsprocesse preisgegeben wurde. Aus dieser Thatsache darf man wohl den Schluß ziehen: „daß die Schädlichkeit der Verwesungsproducte im geraden Verhältnisse zur Höhe der Organisation (der verwesenden Stoffe) und Temperatur und zur Länge der Zeit (Dauer der Einwirkung der letztern) stehe."

Demgemäß ist der Verwesungsproceß der animalischen Stoffe und Ausscheidungen, welcher bei uns durch das jetzige Kloaken- und Kanal-System so sehr begünstigt wird, mehr zu fürchten, als jener der vegetabilischen.

Epizootieen wirken also nur dadurch schädlich auf unsere Sanitätsverhältnisse, daß die krankhaften Auswurfsstoffe oder die Leichen der Thiere verwesen und die Verwesungsproducte sich verbreiten.

4.

Nachdem wir nun aber gegen die Miasmen, den Rückbildungsproceß der organischen Stoffe in der Luft keine Mittel besitzen, so ergibt sich wieder die Aufgabe, gegen die Quelle derselben, gegen den Verwesungsproceß, der besiegbar ist, anzukämpfen. Die Mittel hiezu sind wieder die Factoren gesunder Luft: Wasserreichthum (Begrabung) Vegetation und Dürre.

5.

Dem Einwurfe, daß die Unterwasserhaltung der organischen Abfälle nichts gegen Infection vermöge, da ja gerade stehendes, faulendes Wasser allgemein als Infectionsursache gefürchtet sei, ist damit zu begegnen, daß nicht das Wasser als solches faule, denn es ist ein chemisch so einfacher Körper, daß er einer weitern Rückbildung nicht fähig ist, sondern daß es die im und unter Wasser befindlichen organischen Stoffe sind, welche faulen, indem sie ihre Bestandtheile gegenseitig austauschen, auch wohl das Wasser zerlegen und sich dadurch zu neuen Körpern niederer Ordnung verbinden. Nicht die Fäulnißproducte, welche das Wasser deckt, welche es aufgelöst oder aufgeschwemmt enthält, sind es, welche Gestank und Infection verursachen, sondern die Producte der Verwesung, welche sich in den durch Verdunstung, besonders aber durch Abfluß des Wassers zu Tage getretenen vegetationslosen Ufern und am Rande des Wassers herum erzeugen.

6.

Zur Widerlegung des letzten Einwurfes, daß nämlich die Filtrirung der Ausscheidungen und Abfälle nicht ausreichend genug vorgenommen werden könne, um vor Infection zu schützen und den Verlust der Stoffe zu verhindern, ist anzuführen:

Die Hauptaufgabe zur Vermeidung von Infection und Stoffverlust erfüllt nicht erst das Filtrum, sondern schon die Grube. Bei der Ableitung der Grubenflüssigkeiten, wie sie oben angegeben wurde, kommen alle an und für sich festen oder durch den Fäulnißproceß unlöslich (fest) gewordenen Stoffe gar nicht in den Wirkungsbereich des Filtrums. Die Grube allein verhindert schon die Verschwemmung dieser wegen hoher Organisation infectionsfähigen Stoffe, die Flächengewinnung und den möglichen Verwesungsproceß derselben am Orte der Anschwemmung. Das Filtrum hat eigentlich nur die Aufgabe, die aufgeschwemmten und schwimmenden Stoffe zurückzuhalten. Die Gewinnung der flüchtigen und löslich bleibenden Stoffe aber ist weder in sanitätischer noch in öconomischer Hinsicht eine unabweisbare Nothwendigkeit.

Die Form und der Werth der Abfalls- und Ausscheidungsstoffe fällt mit der Form und dem Werthe unserer Nahrungs-

mittel und jener der Pflanzen, welche das Mittelglied zwischen unseren Ausscheidungen und unserer Nahrung bilden, und deren Ernährung und Fruchtbildung von der Verzehrung unserer Abfälle und Ausscheidungen abhängt, — genau zusammen.

Unsere Nahrungsmittel bestehen aus Luft, Wasser und festen (plastischen) Stoffen; jene der Pflanzen aus Luft (mit ihren Beimengungen) Wasser (mit seinen Lösungen: Regen-, Schneewasser) und festen, plastischen (Abfalls-) Stoffen.

Wie nun Luft und Wasser für uns sowohl als für die Pflanzen kosten- und arbeitslose Nahrungsmittel sind, so sind die festen, plastischen Nahrungsstoffe für beide Theile theurer, mühe- und arbeitsvoller, so jedoch, daß die Arbeit für die letzteren ebenfalls uns obliegt. So wenig ein Mensch ohne plastische Nahrungsmittel gedeihen kann, eben so wenig kann es die Pflanze. So gut sich dem Menschen die Nahrungsmittel, welche durch Luft und Wasser repräsentirt werden, von selbst darbieten, eben so gut geschieht dieß bei den Pflanzen. Unsere Ausscheidungen (Pflanzennahrung) geschehen in Form von Luft, Wasser (Schweiß, Urin) und festen Stoffen (faeces). Während wir nun für die luftförmigen nicht, für die in Form von Wasser ausscheidenden Stoffe nur in soferne zu sorgen haben, daß ihre festen Bestandtheile (Fäulnißproducte) gewonnen werden, müssen wir für die Gewinnung der festen Abfallsstoffe eine unermüdliche Sorgfalt haben. Ein gleiches Verhältniß unter den Stoffen obiger Formen besteht hinsichtlich ihrer Infectionsfähigkeit und Infectionsgefährlichkeit, so daß die festen Stoffe, wie sie die werthvollsten, so auch die gefährlichsten sind.

In sanitätischer Beziehung sind daher die auch nach stattgefundenem Fäulnißprocesse noch löslichen Stoffe — wie denn die flüssigen Defectionen, der Urin, überhaupt — schon so einfacher Natur, schon auf so tiefer Rückbildungsstufe stehend, daß von ihren weiteren Rückbildungsphasen auf ihrem Ableitungswege keine Miasmen mehr zu befürchten sind. Wäre dieß nicht der Fall, wären die Körper auf den Rückbildungsstufen vom Harnstoffe bis zum kohlensauren Ammoniak so giftiger Natur, so müßten wir bei dem unaufhörlichen Vonstattengehen dieses Processes in der größten Flächenausdehnung viel öfter, ja stets zu leiden haben; in öconomischer Beziehung sind die fortgeführten Stoffe größtentheils solche, welche sich durch Luftdüngung (Kohlensäure, Ammoniak) selbst ersetzen oder durch mineralische Düngung (Alkalien, Erden) leicht ersetzt werden können. Ist also auch ohne unverhältnißmäßig großen Kosten- und Müheaufwand einiger Stoffverlust nicht zu vermeiden, so ist gleichwohl auch nicht zu bestreiten, daß es, abgesehen von dem sanitätischen Nutzen, besser ist, man gewinnt fünf Sechstel, als daß man, mit Einschluß der Infectionsgefahr, fortwährend das Ganze verliert. Wie daher die Erhaltung der flüchtigen und löslichen Rückbildungsstoffe in öconomischer Beziehung unnöthig, so ist ihre Ableitung in sanitätischer ungefährlich.

7.

Wollte man aber doch auch die löslichen Stoffe gewinnen, so gelänge dieß durch ein System von Saugröhren (von intermittirend oder permanent wirkenden Hebern), welche in Form einer umgekehrten Brunnenleitung die Lösungen an entsprechende Puncte, Niederungen, Mulden fortführten, wo sie durch Verdunstung des Wassers gewonnen werden könnten.

b. Nebenwirkungen.

Hinsichtlich der angedeuteten Nebenwirkungen bei Anwendung obigen Desinfections- und Stoffgewinnungssystemes ist Folgendes zu erwähnen.

Würde man für die Rückkehr der Dejectionsstoffe in die organische Circulation entsprechend Sorge tragen, so müßte die Nachfrage nach anderen Ersatzmitteln sich verringern.

Würde der Bauer vorerst alle Abfälle seines Hofes gewinnen, würde er ferner wohlfeile, leicht transportable Dungmittel als Rückfracht aus den Städten mitnehmen können, so müßte sich — abgesehen von dem hieraus entspringenden

Nutzen der Städter — die Nachfrage nach Streue, deren Hinwegnahme den Wäldern so viel Schaden bringt, vermindern. Der Bauer verlangt die Streue nicht so fast als Reinlichkeitsmittel für das Vieh, denn als Wiederersatz für die Felder. Würde der Wiederersatz der in Form von Früchten ausgeführten Bodenbestandtheile auf obige Art gegeben, für die Reinlichkeit, glaube ich, wäre auf andere Weise zu sorgen. Wenn man z. B. den Thieren, wenigstens dem Klauenvieh, statt des gehackten, mit Spagat gebundenes Stroh, den Strohdecken der Glashäuser ähnlich, in kleinen Flächen aneinander gereiht, unterbreitete, so würden die Thiere, indem die flüssigen Dejectionen durchlaufen, die festen weggekehrt werden könnten, gut, warm und reinlich liegen.

Es wäre die Reinigung dieser Decken durch Auswaschen und Lüften leicht möglich und jeder würde sich Streue genug erzeugen.

IV.

Maßnahmen bei bereits ausgebrochenen Seuchen.

Diese theilen sich A. in Allgemeine und B. in specielle oder persönliche.

A.

Allgemeine.

Die allgemeinen Maßnahmen beziehen sich wieder auf Verhinderung des Ueberganges des localen Fäulnißprocesses in den Verwesungsproceß.

Die Mittel hiezu bestehen darin, daß wir einen der Factoren gesunder Luft: Wasser, Vegetation oder Dürre, vorherrschend machen; oder aber einen der Verwesungsfactoren: Feuchtigkeit, Luft oder Wärme hinwegnehmen.

1.

Demgemäß sammle man, wenn vorstehende Desinfections-vorrichtungen noch nicht gegeben sind, alle organischen Abfälle des Hauses und der Geschäfte und halte sie in den Gruben unter Wasser, wodurch allein schon zwei Verwesungsfactoren: Luft und Wärme, abgehalten werden. Ist dieß jedoch nicht wohl möglich, nicht nachhaltend möglich, so bedecke man sie gut mit Stroh, oder bestreue die Deckläden mit einer dicken Schichte trockenen Sandes, um wenigstens einen Factor schädlicher Umsetzungen: die Hitze, welcher der gefährlichste ist, abzuhalten. Die Hofräume und Straßen reinige man von solchen Körpern durch Sammlung. Das Spül- und Waschwasser werde, nachdem es geseiht ist, oder ein Filtrum passirt hat, nicht in die Höfe oder auf die Straße, sondern sogleich in die Abzugsrinnen oder in die Canäle geschüttet, damit die in denselben enthaltenen organischen Körper nicht liegen bleiben und schädliche Veränderungen erfahren, die sich der Luft mittheilen. Die durch Seihen oder Filtriren gewonnenen Stoffe werfe man in die Gruben.

Verdächtige fortwährend feuchte Winkel des Hauses oder Hofes begieße man fleißig mit Wasser, oder bedecke sie mit Sand.

Gräben und Canäle versorge man ausreichend mit Wasser, nöthigenfalls durch Sperrung des Abflusses derselben, durch entsprechende Stauung. Diese Vorrichtung sollte jedoch so gemacht werden, daß sie nach erfolgtem ergiebigen Niederschlage, nach reichlichem Regen leicht aufgehoben werden kann, damit das Wasser rasch abfließen und die angesammelten Stoffe mit fortschwemmen kann.

Alle Puncte jedoch, von welchen man weiß, daß sie in Bälde vollständig austrocknen, wie Straßen und Plätze, lasse man unbegossen. Man vergeude das Wasser, welches in solchen Zeiten ohnehin spärlich vorhanden ist, nicht für solche Flächen. Der Staub derselben, bestehend aus zerriebenen Mineralien und vollständig ausgetrockneten organischen Stoffen, ist zwar lästig, aber wenigstens in bezogener Richtung nicht schädlich.

Schutz dagegen gewährt ein vorgehaltenes Sacktuch oder das Anhalten des Athems oder das Ausathmen bei heranstürmenden Staubwolken. Das gewöhnliche Spritzen der Straßen, wodurch die trocken gewordenen organischen Körper den nöthigen Feuchtigkeitsgrad zum Verwesungsprozesse wieder erlangen, ist zweckwidrig hinsichtlich der Desinfection, ungenügend gegen den Staub und ungenügend zur gewünschten Abkühlung. Man lasse es daher ganz weg, oder dehne es so weit aus, daß die fraglichen Punkte immer vollkommen naß sind.

2.

Die Vegetation kommt hier insoferne in Betracht, als man die Pflanzen der Möser, Sümpfe und stagnirenden Gewässer, die zu solchen Zeiten stets halb ausgetrocknet sind, nicht hinwegnehmen soll, weil sie einerseits die Umsetzungsproducte des Bodens absorbiren und verbrauchen, anderseits und vorzüglich jedoch, weil sie durch ihren Schatten die directe Einwirkung der Sonnenstrahlen auf den Boden verhindern.

B.

Specielle oder persönliche Maßnahmen.

Vernünftige Enthaltsamkeit einerseits, aber auch genügende Ernährung anderseits, was bei Militär, in Wechselfieber (Malaria) Garnisonen, insbesondere für die wachthabende Mannschaft Berücksichtigung verdiente, — sind der beste Schutz gegen Krankheiten, deren Ansteckungsstoff in der Luft liegt, gegen miasmatische Krankheiten.

Die hier zu nehmenden Rücksichten beziehen sich theils auf den jeweiligen Zustand unseres Körpers, theils darauf, was mit ihm von außen her in Berührung kömmt, als: Luft, Speise, Getränke &c.

1.

Der Zustand unsrers Körpers ist entweder ein erregter, ein normaler oder ein herabgestimmter (deprimirter).

Im ersten Falle, wobei wir ein fühlbares Pulsiren der Aterien, besonders der Schläfengegend, ein beschleunigtes Athmen und eine feuchte, schwitzende Haut haben, vermeide man Alles, was diesen Zustand rasch, wenn auch nur vorübergehend, noch mehr aber, was ihn rasch und andauernd verändert.

Man vermeide daher nicht blos bei herrschenden Seuchen, sondern überhaupt bei hoher Temperatur, die plötzliche Unterbrechung oder gar Unterdrückung des Schweißes durch Oeffnen der Kleider, Stehenbleiben in der Zugluft (der Wind im Freien ist nicht so gefährlich, weil die hiebei bewegte Luft eine höhere Temperatur als jene hat, welche aus dem Schatten in das Licht, welche aus kühleren Räumen kömmt), durch Genuß kalter Speisen und Getränke. Man bleibe ferner in diesem Zustande nicht unter offenen Thüren, an entgegen geöffneten Fenstern, nicht in ziehenden Gängen stehen und verlange dieß auch von niemand Anderem weder aus Artigkeit noch aus Gehorsam. Die Gesundheit des Mitmenschen muß uns so heilig als unsere eigene sein.

Wenn man von der Bewegung zur Ruhe des Stehens, Sitzens oder Liegens kömmt, so lasse man die Kleider, wie sie während der Bewegung waren, oder noch besser, man schließe sie, ziehe sie noch enger an (Shawls, Mantillen, Röcke) und wische sich die entblößten Körpertheile, insbesondere den Nacken öfters ab, bis das fühlbare Pulsiren, das gehobene Athmen und das Quellen des Schweißes aufhört. Man schließe ferner das Fenster, an welchem man ausruhen will, oder nehme doch außerhalb der Zugbahn, nicht zu nahe insbesondere an untapezirten, ungepolsterten Mauern Platz. Der Mensch ist in diesem Zustande und bei hoher Temperatur überhaupt einem gläsernen Gefäße ähnlich, worin Wasser kocht.

Das verdampfte Wasser muß ersetzt werden. Wendet man hiezu warmes Wasser an, so geht das Kochen gleichmäßig fort, nehmen wir kaltes, so verschwindet es auf einige Zeit und erscheint dann wieder; werfen wir aber Eis hinein, so setzen wir das Gefäß der Gefahr des Zerspringens aus oder werden wegen des zu langen Ausbleibens des Kochens nachschüren müssen.

Diese Momente auf den erregten Menschen angewendet, ergibt sich:

Das Bedürfniß der Abkühlung ist eigentlich nichts anderes als das Begehren nach dem Wiederersatze des verbrauchten, verdunsteten Wassers; dieses wird aber durch warme Getränke eben so gut, wie durch kalte ersetzt, deßhalb ist es besser, sich den Durst mit leichtem Thee oder Caffee, mit Fleischbrühe oder warmer Milch zu stillen, was man unbekümmert um den Erregungszustand unseres Körpers thun kann, als ihn, wenn auch unter der nöthigen Vorsicht, mit kaltem Wasser oder gar mit Gefrornem zu stillen. Gefrornes ist das Unpassendste; es kühlt zu stark ab, ohne den erforderlichen Wiederersatz zu geben. Gutes Bier ist unter den kalten Getränken das Beste, weil es sogleich wieder erwärmt; schlechtes ist dem Essigwasser gleichzusetzen. Von Weinen taugen am besten die moussirenden. Ist man aber genöthigt, den Wiederersatz durch kaltes Getränke zu geben, so trinke man recht oft, aber immer nur sehr wenig, weil sonst, wenn man dem Verlangen schrankenlos nachgibt, mehr Flüssigkeit angenommen wird als nothwendig ist, und der Zustand unseres Körpers hiedurch sowohl als auch durch die zu starke Abkühlung, welche zugleich erfolgt, von der Erregung rasch und dauernd in die Depression hinüber geführt wird, worin er empfänglicher, angriffsfähiger für äußere Einflüsse ist. „In gewöhnlichen Zeiten kann man sich durch „Unachtsamkeit hierin katarrhalische und rheumatische Krank„heiten, in inficirten jedoch die herrschende Seuche holen.“ Ebenso vermeide man den Genuß kalter Speisen und noch mehr den kalter, stark abkühlender schwer verdaulicher Salate, z. B. Gurken.

2.

Im Zustande der Normalität, bei ruhigem Athmen, trockner Haut, vermeide man anhaltenden Zug, Ueberladung des Magens mit Speisen und Getränken (Spirituosa), zu vieles Tabakrauchen und Gemüthsaffecte, weil wir uns sonst plötzlich oder am nächsten Morgen im Zustande der Depression befinden könnten, worin unser Körper gleichfalls widerstandsloser gegen schädliche Einflüsse ist.

Im Uebrigen setze man alle gewohnten Genüsse in vernünftigem Maße fort.

Unschädlich sind alle gebratenen und gesottenen Speisen und alle Getränke, warm genossen, weil durch den Kochproceß alle hieher bezüglichen schädlichen Stoffe ausgetrieben oder unschädlich gemacht werden; bedenklich sind: alle kalten Speisen und Salate, ausgenommen etwa Rettige und Meerrettige, wenn nicht mit zu viel Essig oder Salz behandelt.

Kalte Bäder oder Waschungen nehme man fort, aber nicht sofast um der Abkühlung als vielmehr um der Hautreinigung und Hautstärkung willen. Bäder und Sturzbäder nehme man nicht bis zum Eintritte des allgemeinen Frostgefühles fort. Ueberhaupt ist bezüglich der so sehr gewünschten Abkühlung durch Bäder zu bemerken, daß sie im Uebermaße leicht schaden, im richtigen Maße genommen aber wenig nützen, indem die bewirkte Abkühlung nur kurze Zeit dauert, dann aber der Schweiß in der Regel um so reichlicher quillt. Unangenehm ist eigentlich nur der Ausbruch des Schweißes, nicht aber das Fließen desselben. Schweiß erleichtert und reiniget den Körper, und ist das Mittel, welches uns die Natur verlieh, um hohe Temperaturgrade ohne Schaden aushalten zu können.

Die Fenster des Schlafzimmers sollten wenigstens von Tagesanbruch an bis zum vollendeten Anzuge geschlossen sein.

3.

Im Zustande der Depression, bei dem Gefühle von Oede, Leere und von Druck im Kopf und Magen, tritt, um an das frühere Bild wieder anzuschließen, die Nothwendigkeit des Nachschürens ein, was jedoch mit der größten Vorsicht geschehen muß, damit man bei einer etwa schon gesetzten schwereren Krankheit nicht Oel in's Feuer gieße.

Ist diese Depression das Ergebniß des Tages, herbeigeführt durch Verkältung, durch zu rasche und starke Abkühlung, so suche man durch gleichmäßige Bewegung oder durch Einwicklung die unterbrochene gasförmige Ausscheidung der

Haut wieder herzustellen, — in Schweiß zu kommen, welchen man, wenn eingetreten, gut abwarten muß; ist sie aber das Ergebniß des Morgens, herrührend vom Uebermaße im Essen, Trinken oder Rauchen (Katzenjammer), so bleibe man zu Hause und trinke eine Tasse schwarzen Caffee's mit Citronensäure, stark gesalzene Fleischbrühe mit Eigelb oder esse Eingemachtes mit saurer Sauçe und trinke einen Schoppen guten Biers oder rothen Wein, entweder im Bette oder aufgestanden, nach vorhergegangener Waschung oder vorgenommener Abreibung des ganzen Körpers. Hilft dieß nicht, so säume man nicht, den Arzt zu rufen.

Inzwischen wickle man, wenn Cholera eingetreten, den Kranken in nasse Tücher, welche durch Nachgießen von warmem Wasser fortwährend naß erhalten werden müssen. Daß Wasser zugeführt werden muß, erhellt aus dem starken Abgange desselben aus den Dauungswegen und dem Gefühle des brennenden Durstes, welcher nur durch Wasserzufuhr, nicht aber durch Abkühlung gestillt werden kann; daß die äußere Haut das Organ hiefür ist, ergibt sich daraus, daß das massenhaft genossene Wasser sogleich wieder weggebrochen, also nicht aufgesaugt und dem sich verdickenden Blute zugeführt wird, ferner daraus, daß die Aufsaugung des Wassers von der Oberfläche her während dieser Krankheit eine sehr lebendige ist.

Ein Mann, welcher in Folge von Nierenleiden an allgemeiner Wassersucht litt und bis zum Platzen aufgeschwollen war, lief in 36 Stunden nach Eintritt der Cholera ganz aus, so daß er nach dieser Zeit zum Scelette abgemagert war und ein ganz anderes Bild darbot. Die Cholera hat er überstanden, was wahrscheinlich nur aus seinem Wasserüberflusse zu erklären ist. Daher glaube ich, daß Elimination und Neutralisation des Cholerastoffes die besten Curmethoden gegen diese Krankheit sind: Elimination mittelst entsprechender Wasserzufuhr (Auswaschen), Neutralisation mittelst Darreichen von Calomel.

Schluß.

Nachdem über die Wichtigkeit und Nothwendigkeit der Desinfection und Stoffgewinnung kein Zweifel herrschen kann, nachdem sowohl die Wege der Infection und des Stoffverlustes, als auch die Mittel hiegegen genügend dargethan sein dürften, so hat der Verfasser nur noch Weniges beizufügen.

Die Angaben über Beschaffenheit und Wirksamkeit obiger Instrumente, über die Maßnahmen des persönlichen Schutzes bei herrschender Malaria- und Cholerafeuche sind nicht etwa das Ergebniß des Studierzimmers allein, sondern es sind alle Behauptungen und Angaben entweder experimentell erprobt worden, oder die Richtigkeit der Anschauungen ergibt sich aus Beobachtungen von Verhältnissen, die wir stets vor Augen haben, die oft wiederkehren und die daher als Belege, als Experimente betrachtet werden können, die täglich ohne unser Zuthun ausgeführt werden.

Daß z. B. die Begrabung der Ableitungsflüssigkeit keinen Schaden bringen wird, erhellt aus dem Verhalten der Leichenäcker, von woher wir, obgleich die daselbst befindlichen Körper höchst zusammengesetzter (von höchster Organisation) — hingegen die Stoffe der Ableitungsflüssigkeit sehr einfacher Natur sind, keine schädlichen Einflüsse nachzuweisen im Stande sind; daß die Inwassersetzung oder Unterwasserhaltung verwesender oder faulender Stoffe vor Gestank und Infection schützt, ersehen wir neben tausend andern Dingen auch daraus, daß höchst übelriechende krankhafte Absonderungen aufhören, unsere Sinne zu beleidigen, sobald dieselben oder das absondernde Glied selbst in's Wasser (Bad) gebracht werden, ferner daraus, daß wasserreiche Sümpfe, Flüsse, Seen und das Meer, in denen und unter deren Wasserdecke doch gewiß ein ungeheurer Rückbildungsoproceß von statten geht, keine üblen Einflüsse ausüben.

Durch Anlage obiger Gruben würden endlich nicht nur der größte Theil der Aschenbestandtheile der Abfallsstoffe, sondern auch viele Stickstoffverbindungen gewonnen, was sich

aus der Beschaffenheit der festen Stoffe, in denen vermöge bleibender Organisation die Alkalien, die Erden und der Stickstoff mit den übrigen zur Organisation beitragenden Elementen zusammengehalten bleiben, und ihre Rückbildung erst im Felde, dem sie als Düngstoffe einverleibt werden, erfahren würden, — und aus jener der unlöslich gewordenen Fäulnißproducte ergibt.

Die allgemeine Anwendung dieses Reinigungssystemes, welches in Städten mit schiffbaren Flüssen und Canälen in Form von Guanoschiffen statt der angegebenen allgemeinen Gruben auftreten könnte, würde überdieß den großen sanitätischen und pecuniären Vortheil einer baldigen, radicalen Reinigung der mit Abfallsstoffen aller Art verunreinigten Städte dadurch herbeiführen, daß den Ausdünstungs-Herden der Abzugscanäle, der Kloaken und Flüsse die Zufuhr abgeschnitten, und die in denselben schon befindlichen Stoffe allmälig fortgeschwemmt oder in die letzten unschädlichen anorganischen Verbindungen übergeführt würden, welches Ziel durch Räumung, wie sie bei der Themse projectirt war, ohne Vermeidung der Zufuhr von neuen Dejectionsstoffen auch bei dem größten Aufwande von Zeit und Geld nur vorübergehend zu erreichen ist.

Es würde also eine Gesellschaft, welche sich zu diesem Zwecke bildete, außer den unbezahlbaren Verdiensten um die Verbesserung der Sanitätsverhältnisse ein gutes Geschäft durch Verwerthung der gewonnenen Düngemittel machen und in Bälde gute Dividenden ausbezahlen.

Druck der M. Pössenbacher'schen Buchdruckerei.

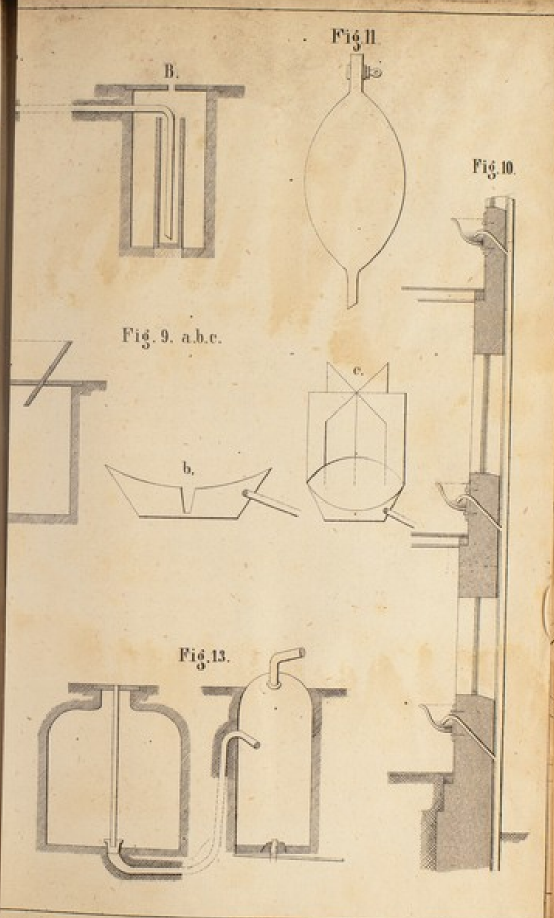

Fig. 11.
B.
Fig. 10.
Fig. 9. a.b.c.
c.
b.
Fig. 13.

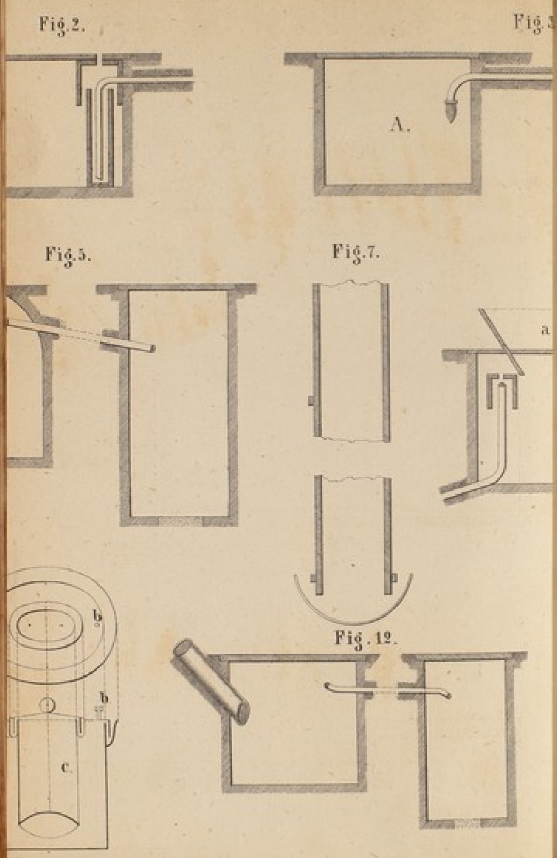
Fig.2.
Fig.3
A.
Fig.5.
Fig.7.
a
b
b
c.
Fig.12.

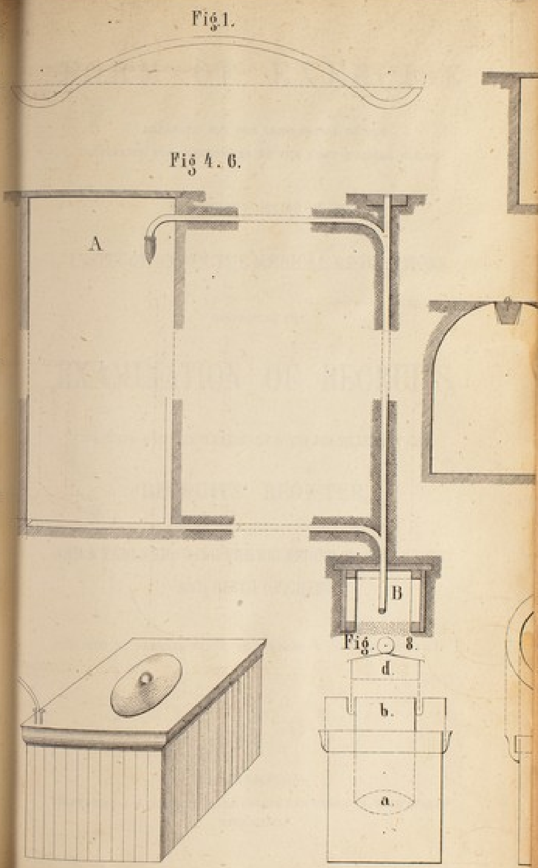
Fig.1.
Fig 4. 6.
A
B
Fig. 8.
d.
b.
a.

FORM OF EXERCISE

ARRANGED FOR THE INFORMATION OF THE
CANDIDATES FOR COMMISSIONS AT THE ARMY MEDICAL SCHOOL

TO ASSIST IN CARRYING OUT THE

INSTRUCTIONS IN THE MEDICAL REGULATIONS

RESPECTING THE

EXAMINATION OF RECRUITS,

TOGETHER WITH SUPPLEMENTARY NOTES FOR FILLING UP THE

RECRUITS' REGISTER,

AND A TABLE SHOWING THE RELATIONS OF AGE, HEIGHT
AND GIRTH OF CHEST

REQUIRED BY GENERAL ORDER IN DIFFERENT CORPS OF THE ARMY

SOUTHAMPTON:
PRINTED BY J. J. BENNETT (LATE FORBES AND BENNETT), HIGH STREET
MDCCCLXIII.

FORM OF EXERCISE

FOR THE EXAMINATION OF RECRUITS.

THE following exercise is arranged with the object of showing how the Instructions for the Inspection of Recruits, in the Medical Regulations, page 99, may be carried out methodically, completely, and at the same time with the least expenditure of time. If this exercise be exactly followed, and due attention be observed, it is believed that all risk will be avoided of overlooking any of the disabilities incapacitating recruits for military service which are laid down in the regulations above referred to.

The system adopted is briefly a division of the Examination into two parts—the first being a general physical examination of the recruit; the second, a special examination of the recruit in detail. The second part, or the detailed examination, is for convenience separated into four subdivisions, viz., A, the trunk; B, the lower extremity and back; C, the upper extremity; and D, the head and neck.*

* I would refer those who wish to find more full information than the Orders in the Medical Regulations afford, on certain special subjects connected with Recruiting, to the excellent works of Surgeon Massy, 2nd Dragoon Guards on the "Examination of Recruits," and to that of the late Deputy Inspector General H. Marshall, entitled:—"Hints to Young Medical Officers on the Examination of Recruits." Much interesting matter of a general nature in reference to this important duty will also be found in these volumes.—T. L.

Mem.—When not required to approach the recruit for special objects the surgeon should always take his place at about a distance of six feet from him. The recruit should be placed so that the light may fall upon him.

PART I.

GENERAL EXAMINATION OF THE RECRUIT.

The recruit being wholly undressed, the following directions are given *seriatim* :—

1.—Walk up and down the room smartly two or three times.

2.—Hop across the room on the right foot.

3.—Back again on the same foot.

4.—Hop across the room on the left foot.

5.—Back again on the left foot.

(The hops should be short and upon the toes.)

6.—The recruit is halted, standing upright, with his arms extended above his head, while the surgeon walks slowly round him, carefully inspecting the whole surface of the recruit's body.

[*Remarks.*—This completes the general examination. The objects to be observed and noted in this part are the following:—The existence of any obvious defects in physical constitution; the formation and development of the limbs; the power of motion in joints, especially in the feet and hips; flatness of feet; formation of the toes; skin disease; varicose veins; cicatrices of ulcers; marks of surgical treatment, as leech bites, cupping, blistering, seton at back of neck, &c.; marking by the letter D or letters B C; and any special marks, from tattooing, or from congenital, or accidental causes. If any obviously disabling defects are noticed in the general examination, it is, of course, not necessary to proceed with the exercise farther. If no such defects are found, the second part of the examination is at once proceeded with.]

PART II.

SPECIAL EXAMINATION.

A—*THE TRUNK.*

The trunk is examined from below upwards. The recruit stands with his arms extended above his head, the backs of the hands being in contact. The following is the order of inspection :—

1.—The surgeon notes indications of gonorrhœa or syphilis.

2.—The surgeon examines the scrotum to feel if the testicles have descended and are normal, or if there be varicocele.

3.—The surgeon places the forefinger of each hand in the corresponding external abdominal ring, and desires the recruit to cough two or three times.

4.—The surgeon takes a survey of the abdominal walls and parietes of the chest.

5.—The surgeon desires the recruit to "take in a full breath" several times, while he watches the action of the chest. If the expansion be not perfectly normal, a careful stethoscopic examination is made.

6.—The surgeon examines the action of the heart, and notes its sounds.

7.—The measurement of the chest is taken by the regulated method. (See page 8.)

[*Remarks.*—This sub-division comprehends the inspection for venereal disease, disease of the testis, varicocele, hernia, visceral disease of the abdomen, visceral disease of the chest, and capacity of chest.]

B—*THE LOWER EXTREMITIES AND BACK.*

This inspection is made from below upwards. The recruit first faces the surgeon, afterwards turns his back to him. The following are the directions given :—

1.—Stand on one foot, put the other forward.

2.—Bend the toes backward and forward. Bend the ankle joints backwards and forwards.

3.—The same directions are repeated for the other foot.

4.—Turn round. Kneel down on one knee.

5.—Up again.

6.—Down on the other knee.

7.—Down on both knees.

8.—Separate the knees.

9.—Touch the ground with the head.

While the recruit performs these movements, the surgeon observes ~~examines~~ the action of the knee joints, the condition of the perinæum, and of the spinal column. It is not necessary to touch the recruit.

[*Remarks.*—This sub-division includes the inspection for defects of the toe, ankle and knee joints; for hœmorrhoids; prolapsus ani; fistula in perinæ; and spinal deformity.]

C—*THE UPPER EXTREMITY.*

This examination is made from below upwards. Time is saved by the surgeon himself acting as well as telling the recruit the movements he desires to be made. The following are the directions:—

1.—Stretch out your arms with the palms of your hands upwards.

2.—Bend the fingers backwards and forwards.

3.—Bend your thumbs across the palms of your hands.

4.—Bend the fingers over your thumbs.

5.—Bend your wrists backwards and forwards.

6.—Bend the elbows.

7.—Turn the backs of the hands upwards.

8.—Swing your arms round at the shoulders.

9.—The surgeon approaches the recruit and examines for marks of vaccination.

[*Remarks.*—This comprehends the inspection for loss of portions of the fingers; defects of the finger, thumb, wrist, elbow and shoulder joints; power of rotating the forearm; and vaccination.]

D—*THE HEAD AND NECK.*

The examination is made from above downwards. The surgeon notes the intelligence, character of voice, and auditory power of the recruit by his replies to the questions put to him. The following are the directions:—

1.—Have you had any blows or cuts on the head? Are you subject to fits or giddiness? The surgeon at the same time examines the scalp for cicatrices.

2.—The surgeon examines the ears for otorrhœa.

3.—Do you see well? The surgeon examines the superficial parts of the eyes.

4.—The surgeon examines the nostrils.

5.—The surgeon examines the mouth, palate, and fauces, and then tells the recruit to say "Who goes there?"

6.—The surgeon examines the cervical region.

7.—The recruit is desired to dress himself.

8.—The special tests for power of vision are applied to each eye.

[*Remarks.*—This comprehends the inspection for injuries of the head; deafness; disease of the ears: defect of voice; polypus nasi; loss of teeth; scrofulous ulceration; glandular enlargements; and defects of vision.]

REGISTER OF RECRUITS.

SUPPLEMENTARY INSTRUCTIONS FOR FILLING UP THE COLUMNS OF THE REGISTER OF RECRUITS.

The Form of the Register of Recruits is shown in page 136 of the Medical Regulations. General instructions for filing up the Register appear in page 115, and some further instructions on this head will be found in page 101, of the Medical Regulations. The following are supplementary instructions referring to each of the twenty-six columns of returns in the Register successively :—

1.—" Date." Here insert the date on which the inspection is made.

2.—" Regiment." Here insert the regiment, or service, for which the recruit intends to enlist.

3, 4, 5.—The " Name, age, and height " are copied from the statements in the attestation document which the sergeant brings with the recruit.

6.—" Weight." This should be filled in when the means of weighing the recruit exist.

7.—" Circumference of the chest over the nipples." By General Order, 14th January, 1862, the recruit while being measured is to stand with his arms placed straight above his head, with the backs of his hands in contact, at the same time that he counts from one to ten. The term "over the nipples" signifies immediately above the projections

formed by the nipples. The object of making the recruit count numbers is to prevent any attempt on his part to keep the chest unnaturally distended during the measurement. The circumferential measurement is made by a tape marked with divisions of inches, and care must be taken at the time of measurement that the tape is on the same plane behind and before the chest. This method of measurement does not give an exact indication of the size of the chest, as it is influenced by the projection of the scapulæ, which are included in the measure, and are thrown outwards in some men more than in others by the position above designated, but it answers the purpose of complying with the orders as to the required relations of the girth of the chest to the man's height (see Table, page 11.) As the mobility, or extent of expansion, of the chest, is a very important indication of the probable fitness of an individual for a service where great endurance, and occasionally great exertion, are required, it is useful to take a measurement by the tape when the chest is filled to its utmost with air by inspiration, and another when it is as completely exhausted as possible by expiration. The measurement may be expressed thus, $\frac{34}{33}^{\text{in}}$. The indications by this plan of measurement, if made with care, appear more satisfactory for recruiting purposes than those given by any of the mechanical stethometers in ordinary use.

8.—" Marks of vaccination." Here the entry must be " Right arm," " Left arm," " Both arms," " Right leg," according to the position of the marks, if the recruit has been vaccinated ; S P if he bears marks of small pox ; or " No marks," if none be present. See also the instructions in page 101, of the Medical Regulations.

9 to 14.—" Place of Birth." The parish and county should be written in full. The part of Britain may be designated by a stroke in the respective columns : if born in a foreign country or British colony, the country or colony must be stated in the proper column.

15.—"Trade or occupation." See the Special Instructions for filling up this column in pages 138 and 139 of the Medical Regulations.

16 to 19.—"State of Education." If the recruit can both read and write, and his replies show general intelligence, the surgeon may mark the recruit in the first column, as the expression "well educated" doubtless has reference to the ordinary condition of a soldier. A mark must be made in either of the remaining columns of this section, according to the ascertained condition of each recruit, as to their respective headings.

20 to 23.—"Primary and Secondary Inspections." See Instructions in the Medical Regulations, page 115.

24 to 25.—"Transfers from Militia." The documents accompanying the recruit will inform the surgeon when the recruit has been transferred from the Militia.

26.—"Causes of Rejection." "Remarks." The causes of rejection are ordered to be stated according to the nomenclature of the statistical nosology, form H, page 140 of the Medical Regulations. The "Remarks" must express concisely any observations the surgeon may think it important, or likely to be serviceable, to record, in case of future reference respecting the recruit, as well as a brief description of any blemishes or peculiar marks, as tattooing, &c.

I append a Table which has been constructed to show at a glance the Orders at present in force concerning the age, height, and size of chest, required for recruits in the various branches of the service.

THOMAS LONGMORE,
Deputy Inspector General, Professor of Military Surgery.

Army Medical School, Netley,
October, 1863.

FOR AND AGAINST TOBACCO;

OR

TOBACCO IN ITS RELATIONS TO THE HEALTH OF INDIVIDUALS AND COMMUNITIES.

BY

BENJAMIN WARD RICHARDSON, M.A., M.D.,

SENIOR PHYSICIAN TO THE ROYAL INFIRMARY FOR DISEASES OF THE CHEST.

LONDON:
JOHN CHURCHILL AND SONS,
11 NEW BURLINGTON STREET, W.

1865.

LONDON:
PRINTED BY EMILY FAITHFULL,
PRINTER AND PUBLISHER IN ORDINARY TO HER MAJESTY,
VICTORIA PRESS, 83A FARRINGDON STREET, E.C.

CONTENTS.

ON TOBACCO:

IN ITS RELATIONS TO THE HEALTH OF INDIVIDUALS AND COMMUNITIES.

INTRODUCTION.

THE facts and inferences to be presented in the following pages, were collected, in part, in the year 1862, for a paper intended to be read at the London meeting of the National Association for the Promotion of Social Science.

Unfortunately, I commenced the inquiry too late to be able to complete it in such a way as, on becoming fully conversant with it, I thought it deserved; and it is not until the present time that I have felt warranted to speak, lest I should place myself among those numerous disputants who, ever since the days of the author of the famous "counterblaste," have spoken but have not studied.

In this work it is my intention to found every position on individual research. In some instances, truly, the research will rest on the previous labours of other inquirers, but in all cases the evidence rendered will be confirmed by new observation. Again, it is my hope to write throughout without bias. The arguments for and against tobacco, as they have been delivered, have been based on so little real knowledge, and expounded with so much unequal vehemence, that I, for one, have never been able to come to any conclusion respecting their value; and I presume the large majority of people have felt the same difficulties, for I observe that the number of protesters against tobacco have increased in proportion to the increase in the number of smokers and in the tobacco returns of the revenue.

I need say little more by way of introduction, except to solicit the patience of readers. They must not turn to any of these papers to find dogmatic statement and the bold *ipse dixit*. They must learn as I have learned, if they would follow me. They must be content to begin with principles simply stated, and to draw conclusions from data as nearly positive as may be obtainable. Now to the work.

CHAPTER I.

ON THE COMPOSITION OF THE SMOKE OF TOBACCO.

Before we can proceed to offer any remarks bearing upon the action of tobacco on the body of the smoker, it is essential that we should possess a perfect knowledge, in so far as such knowledge can be rendered perfect, of the chemical substances to which the smoker is exposed during the act of smoking. As yet, the chemistry of tobacco has been mainly written on the basis of experiments made to determine the properties of tobacco-leaf, without reference to the peculiar mode by which the leaf is decomposed in a pipe or cigar. I have not considered this procedure as fair, and have therefore followed a new plan. I constructed a small pair of bellows on a principle which made them act as the lips and chest of the smoker act in the process of smoking. The bellows, in these experiments, drew over the air in small whiffs; part of the smoke produced by the combustion was allowed to escape from the mouth of the pipe or the lighted end of the cigar, as occurs in ordinary smoking, while the remaining portion of the smoke, which in the man would be taken into the lungs, was drawn into the bellows, and subjected to analysis.

Thus, the condition of the smoker was accurately imitated, and the products to which he is exposed were carefully determined, in relation both to their quality and to their quantity.

To make the examination still more certain, different specimens of tobacco were used: different kinds of pipes were also employed—the fine porcelain bowl and stem, the small cutty, the long churchwarden, the virgin pure clay, the black odorous "coloured" clay, the meerschaum, new and "coloured," and the wooden pipe, in different stages of its development towards what your tobacco epicure calls a "gem specimen."

We shall see as we progress that the widest differences prevail in respect to the products arising from differing cigars, differing kinds of tobacco, and differing pipes; but it will be well, as a preliminary, to lay before the reader an account of the substances which are common to all varieties of tobacco smoke. For it is to be observed that such differences as exist are due to quantity rather than to quality, and that in every variety there are present certain bodies of which the smoke may be said to be composed.

Firstly. There is in all tobacco smoke a certain amount of *water vapour*, which may be readily condensed by passing the smoke through a glass globe surrounded by a freezing mixture; this water is always impregnated with other substances, from which it may be separated, and it varies in quantity even in the purest specimens of the plant, according to the extent to which the plant has been exposed in desiccation or drying, before it is subjected to experiment. We may consider the water as

innocuous, unless it be the bearer of soluble substances which possess active properties.

Secondly. There is present a small portion of free *carbon*. The existence of the carbon may be determined by the mere mechanical act of driving the smoke through cotton-wool. The carbon is deposited on the fibre of the cotton as a fine powder, rendering the fibre dark and dusty. It is to the presence of this carbon that the blue colour of the smoke is due. Those dense clouds which the energetic smoker blows forth, and those delicate eddies, ripples, circles, and curves, which the refined artist watches with so gratified an eye, are all due to an almost infinitesimal trace of free carbon. It is this carbon which in confirmed and inveterate smokers settles on the back part of the throat, and on the lining membrane of the bronchial tubes, creating often a copious secretion, which it discolours, and which is coughed up of dark coaly appearance.

Thirdly. There is in the smoke a portion of *ammonia*. The presence of this body may at any time be proved by a very simple and ready experiment. Take a piece of white glass plate, and spread over it, in the centre, a little dilute hydrochloric acid (spirit of salt). Invert the plate over the bowl of a tobacco-pipe, charged with burning tobacco; and, holding the plate an inch above the mouth of the bowl, blow a few whiffs of the smoke over the surface moistened by the acid. The ammonia present will be seized by the acid, and converted into hydrochlorate of ammonia (sal ammoniac), or, to designate it more correctly, chloride of ammonium. On drying the fluid on the glass with a very gentle heat over a candle or before a common fire, the chloride remains on the glass as a beautiful frosted crystalline deposit. Examined by the microscope with the one-inch lens, this crystalline deposit presents a very characteristic appearance; the crystals arrange themselves in various forms: like feathers, like daggers, or even like small swords, with here and there a finely marked and separate cube. Technically these crystals are defined as anhydrous (*i.e.*, they contain no water), having a cubical or octahedral shape. The ray-like distribution on the plate depends on the manner in which the separate crystals arrange themselves.

The presence of the ammonia in the smoke of tobacco gives to the smoke an alkaline reaction. This may be proved by using a slip of paper that has been saturated with litmus, and afterwards reddened by exposure to an acid: the reddened litmus, having first been moistened with water, has only to be exposed to the smoke issuing from a pipe, when the red colour will disappear and the paper will return to the original colour given to it by the litmus, blue. The ammonia of tobacco smoke plays a very important part: it is the ammonia that bites the tongue after long smoking; it is the ammonia that makes the tongue and throat of the smoker so dry, and induces him to quaff as he smokes, and that partly excites the salivary glands to secrete so freely. The ammonia also exerts an influence on the blood, of which more will be said in its proper place.

Fourthly. *Carbonic acid* is always present in the smoke of tobacco. This may be shown by dipping the bowl of a pipe holding burning tobacco, for a few seconds, in a long bottle containing a little fresh lime-water. After the space in the bottle above the water is charged with smoke, withdraw the bowl, insert the stopper of the bottle, and

shake the lime-water briskly, so as to bring it into contact with the vapour. The lime-water will now become of milky whiteness, owing to the formation of carbonate of lime. In this experiment the tobacco smoke must not be driven by the breath into the lime-water; for that would vitiate the result, as the breath contains carbonic acid. The amount of carbonic acid produced by the combustion of various specimens of tobacco differs so greatly that it is difficult to estimate the general effect of the acid; the inference, nevertheless, is fair that the sleepiness which follows on the prolonged inhalation of tobacco-fumes, as well as the head-ache and lassitude, are largely due to this agent, which in so small a proportion as five per cent. in the air inspired produces the symptoms specified.

Fifthly. There is yielded from tobacco smoke *a product having an oily appearance.* This substance is only partially condensable by exposure to a freezing mixture; it is also absorbed by water only in a small degree; but it appears to be all fixed by sulphuric acid, to which it imparts a dark colour. The colour of the oily product itself differs in shade according to the tobacco from which it is derived, but in a general way it has the colour of common olive oil: it constituted the substance called by Vauquelin "*nicotine.*" The substance, on examination, is however found to be a compound body; and the term nicotine is now not applied to it in the manner suggested by the chemist named above. The "oil" derived from the tobacco by condensation, possesses poisonous properties. Sufficient of it may be obtained from a common Havannah cigar, weighing 63 grains, to excite poisonous, but not fatal symptoms in a rabbit. On the administration of the substance, the animal within two minutes is seized with tremors, partial insensibility, and paralysis, especially of the hinder limbs; but the symptoms pass off with great rapidity: they subside usually in from three to four minutes, leaving the animal apparently uninjured.

The "oil" (so called) derived from tobacco smoke by condensation, yields, on further analysis, evidence of the presence of three bodies, viz., a fluid alkaloidal body, called *nicotine;* a *volatile substance* having an empyreumatic odour, and an *extract* of a dark resinous character having a bitter taste. Respecting the properties of these, it may be briefly stated that all symptoms of tremor, palpitation, and paralysis, after smoking, seem to depend on the nicotine; the peculiar smell of stale tobacco smoke, which hangs so long on the breath of the smoker and on articles of clothing, is derived from the volatile empyreumatic substance; and the exceedingly nauseous sharp taste which is recognised by every unpractised smoker when he takes a foul pipe into his mouth, is due to the bitter extract. It is, I believe, this extract which creates vomiting in persons unaccustomed to tobacco, and of which the body after a time becomes tolerant.

Thus, for the production of the effects caused by tobacco on the human body, there are many and different substances: in other words, the smoke of tobacco being compound, the symptoms it produces are also compound. It has been the custom, however, up to the present time, to consider the alkaloid *nicotine* as the author, one and indivisible, of the smoker's pleasures and pains. The hypothesis is utterly groundless: *nicotine,* although one of the most potent substances, is the last, owing to the smallness of its

amount and its little volatility, to exert effects on the smoker. It is only, in fact, after prolonged smoking that it reaches the blood at all: then truly it becomes the most active poison of the group, exciting symptoms which are at all times dangerous, sometimes fatal, and which, but for the rarity of their occurrence, would have excluded tobacco as a luxury at its first origin, without any aid from the moral crusaders against the weed.

CHAPTER II.

THE FIRST EFFECTS OF TOBACCO ON THE BODY.

I placed before the reader in my last chapter an account of the different products to which the smoker of tobacco is exposed while smoking. I also noticed briefly the special effects of these different products. It may be well in the present chapter to inquire:—What are the general physiological effects of tobacco on the animal organism?

It is proper in answering this question to say *effects*, for, in truth, as I have before intimated, the smoke has a compound action on the body. It exerts an influence on the blood, on the muscles, on the brain, on the stomach; and it acts by virtue, not of one but of many substances, viz., carbonic acid, ammonia, a volatile empyreumatic principle, an alkaloid called nicotine, and a bitter extract.

The physiological evidence we possess leads us to assume, nearly conclusively, that the first impression exerted by tobacco smoke is on the blood. It is, in fact, almost certain that the products borne in the fumes (which, without alarming the most tremulous smoker, we may, for the sake of scientific accuracy, call poisons), act on the system in the precise degree that the blood, receiving them by the lungs, absorbs and retains them; and, as the different substances named are absorbed by the blood and

retained by it in different proportions; and, as the blood under various states absorbs the same substance with various degrees of power, it follows naturally that the effects of tobacco smoke are not the same in degree in different persons, nor the same in the same person at all times.

That a clear idea may be obtained in respect to the general or compound action of the smoke of tobacco, I will first describe the conditions it induces in their extreme development. I will show the order of its effects in their rapid or acute form, and from that will descend, the more readily, to the consideration of the slower, and, as they may be called, chronic effects of tobacco—those effects which are observed in persons who are said to be confirmed smokers.

The action of tobacco smoke extends to all the animal kingdom: it exerts an influence on everything living. We place a few mites from a cheese under the microscope, and direct upon them a current of tobacco smoke from an ordinary pipe. In a few seconds the little animals reel over, their limbs become convulsed, and they even appear to die; but on them the effect of the air is most active, and as the poisonous vapours exhale readily from their bodies, they recover after a time. On flies, and bees, and wasps, the same consequences may be observed, after they have been exposed to the smoke. Frogs also succumb to it but slowly, and birds very rapidly. On cats, rabbits, dogs, pigs, the symptoms produced are powerfully marked at first, and, taking into account the difference in size of the animals, the phenomena presented are the same in character. I may note, as a preliminary fact, that it is no difficult matter to kill an animal by the fumes of common tobacco, and this even if the air be constantly changed, granting that, as it enters the chamber, it is charged with the smoke. On dogs, in fact, the fumes of burning tobacco are infinitely more potent than those of opium. Thus, if a small dog, or a cat, be placed in a chamber capable of containing three thousand cubic inches of air, and the smoke derived from a quarter ounce of shag tobacco be passed through the chamber, the symptoms of tobacco poisoning will show themselves within the first fifteen minutes, and in from half to three quarters of an hour death will take place. The symptoms, from inhalation in a similar way, will also show themselves quickly in man, although the experimentalist be inured to smoking. I myself once inhaled the product from one pipe holding sixty grains of tobacco, the said product being diffused through five-thousand cubic inches of common air; within four minutes the signs of specific tobacco poisoning set in, and I was compelled to desist.

In different cases of tobacco poisoning the same symptoms are always present, but they are not always each and every one present in the same degree. The quality of the tobacco, the character of the pipe, the state of the smoker—nay, the temperature of the room in which the poisoning takes place, cause differences in detail. Still, the symptoms are sufficiently blended in most instances to admit of being followed out with fair precision.

Inasmuch as the first impression is made on the blood, and inasmuch as the whole volume of blood courses through the body in from three to five seconds, the first symptoms of tobacco smoking are felt universally.

There is said to be an "all-overishness," by which term, bad as it is, a great deal is implied. After a short time, as the blood becomes saturated with the poisons, the more vascular organs, and those which have the most active functions, become powerfully impressed. The stomach is the first to give indication of suffering; and an effort is made through that organ to eliminate certain of the offending substances. If the poison cease to be taken in at this point, or if the quantity that has been received be not immoderately large, recovery commences. The surface of the skin resumes its ordinary colour and temperature, and after a few hours the ordinary functions of life are once more naturally performed; for tobacco is not a poison that leaves important disease of any particular organ or class of organs in its track; if it did, that mischief, which would soon have been detected by physicians, would have excluded it long since from the list of luxuries.

If the process of poisoning be continued beyond the point to which we have followed it, the brain and nervous system next become affected: there is now presented an inability to stand steadily, and to make a sure grasp of objects near: the body seems to whirl and all things around to reel—effects which are soon followed by involuntary action of the muscles, and convulsions which are often intensely painful. In extreme cases, this muscular spasm extends to the muscles of the chest and to the heart, and thereupon succeeds a deathly faintness and tremor. I once saw a boy, who, on "learning to smoke," induced in himself, from the first few pipes, these signs in a degree that was most painful to witness: his heart having nearly ceased to beat, his sensation of impending death was terrible, while through his chest—which was spasmodically fixed, as if surrounded with an iron band—whenever he attempted to breathe there darted a pain short and sharp as a shock from a powerful galvanic pile. These spasmodic seizures lasted for many hours.

Pushed to an extremity, the symptoms terminate in death: and in the lower animals the death invariably is due to arrest in the beating of the heart: in the human subject, if fatal symptoms supervened, they would be due to the same cause.

In common conversation we speak of tobacco as a narcotic poison, and the anti-tobacconists are everlastingly dinging into our ears their statements respecting the effects of this terrible "stupefying" drug; but, in truth, the idea that tobacco is a narcotic is as false as it can be: tobacco is no more a narcotic than is strychnia; if it were, it would be infinitely a more grateful friend at first sight than it is. Your true narcotic is really a seducing body, that asks you to apply to it again, with a meaning that is pleasant at the time, and not unpleasant afterwards to the recollection; but tobacco raises its victim's whole soul into a fervour of abhorrence. It is so candid that it tells you at once, "I am a devil, and these are my tortures: try them again, if you dare."

For my own part, I have luxuriated in a bath of laughing gas; I have been under ether and chloroform; and once, by an accident, in which Battleys' solution of morphia was given me, in a mixture, in mistake for tincture of bark, I tasted opium freely, and I know from these experiences what a true narcotic is. I can recall at any time the visions produced by the laughing gas and the opium; how to the mind all the universe seemed enlarged, and space lost in space; how in what was but a second of time centuries were first closely enrolled and then expanded into vast history; how every sense was exalted, and imagination seemed so far set free that the dull body was left behind, having no control, and subject to none; and the visions thus recalled are something to think upon, like visits to magnificent pictures, or great cathedrals, or unrivalled landscapes, or opera in its highest art. But the recollection of these by the recollection of tobacco poisoning, is to compare the extremes of happiness and torture—incarceration in cutting irons in a Southern slaveholder's worst cell, with a banquet at the Crystal Palace on a fine day of July, in the company of England's merriest men and best scholars.

I have digressed for a moment, but the digression is pardonable if the fact be impressed on the mind, that tobacco is not a narcotic; that is to say, that it does not remove sensation, nor excite pleasurable emotion.

The symptoms called into existence by the rapid inhalation of tobacco smoke may be produced in the same degree by a different mode of administration. If instead of letting the fumes pass into the lungs of a man or animal, we condense them by drawing them through a globe surrounded by a freezing mixture, we obtain in solution all the products, minus the carbonic acid gas, and a portion of the ammonia. If this solution now be given by the mouth, the same symptoms are induced as by inhalation, but with this difference in regard to time, that they are immediately developed. Thus the fluid condensed from one good Havannah cigar is capable of inducing in a rabbit active convulsions without death, while the fluid condensed from six ordinary pipes of common shag tobacco, smoked precisely as a man would smoke them, is sufficient to destroy a rabbit within three minutes after the administration.

There is one other point to be considered in this chapter. It will be asked, what are the conditions of the organs of the body during the time that a person who is learning to smoke is undergoing his penance? As regards the human body, neither I nor any other physician could speak with certainty, for the facts have not been observed; but from analogy derived from the inferior animals, which analogy must be very perfect, the conditions of the vital organs are as follow:—The brain is pale and empty of blood; the stomach is reddened in round spots, so raised and pile-like, that they resemble patches of dark Utrecht velvet; the blood is preternaturally fluid; the lungs are pale as the lungs of a calf, as we see them suspended in the shambles; while the heart, overburthened with blood, and having little power left it for its forcing action as a pump, is scarcely contracting, but trembling as if, like a conscious thing, it knew equally its own responsibility and its own weakness. It is not a beating, but a fluttering heart: its mechanism is perfect, but each fibre of it to its minutest part is impregnated with a substance which holds it in bondage and will not let it go.

Tobacco, then, if it be a friend, is not very friendly at the first introduction; fortunately, or unfortunately, it becomes

milder as it grows more familiar; but for all that, if any person who was asking himself whether or not he should cultivate its acquaintance, had seen what I have seen, he would surely decline the honour, and that, even though he might know of certain after advantages from the friendship, to which we shall be led in due time.

CHAPTER III.

THE SLOW EFFECTS OF TOBACCO SMOKE ON THE BODY.—INFLUENCE ON THE BLOOD.

The body, after being subjected for a few times to the poisons of tobacco smoke, becomes accustomed to their influence, and ceases to offer any of the immediate and active signs of opposition. There is set up what is technically called "a tolerance," and the direct mischief seems to be over. The "tolerance" thus brought about is not peculiar to tobacco as a poison. There are many other substances which in like manner are tolerated after a time. Antimony, as a ready example, is one of these: there is no poison more sickening, more depressing than antimony when it is first taken; but very soon it ceases to exert its active properties, and can be swallowed in moderate doses for a long time, though a poison—tolerated, and apparently little hurtful. Some mystery has been made to surround this change by which tobacco and other poisons become endurable; but in truth there is no necessity for any mystery or any difficulty. The fact is that the animal organism is formed to adapt

itself to many impressions and influences, which at first sight are objectionable, by virtue of a physical power it possesses of getting quickly rid of the offending bodies, and relieving itself of them. This occurs in respect to tobacco. After a short time the products of the tobacco find a ready exit out of the system. They are thrown out by the three great eliminatories—the lungs, the skin, and the kidneys. The volatile matters exhale by the lungs. We have evidence of that in the empyreumatic and ammoniacal breath of every heavy smoker. In confirmed and inveterate smokers, their every garment, after a short wearing, becomes impregnated with the smell of tobacco; and we say that the smoke hangs about their clothes, as though the smoke had simply fallen on the clothes from without; but this is not quite the fact: the vapour has in truth largely exhaled from the skin, and saturated the clothing. For the same reason the clothes of some moderate smokers are intensely fumigated; so that into whatever company they go, and however they may dress, they bear with them the evidence of their indulgence. A gentleman who was a very moderate smoker once consulted me on this subject, telling me, "If I smoke but a single pipe or cigar, I carry it about with me for half a day, whereas my brother smokes a dozen pipes and nobody would suspect half an hour afterwards that he had smoked at all;" and these observations are commonly made, although the causes of the phenomena are not understood. Nevertheless, they may be understood. When the smoker carries about with him the odour of a single pipe, he has some defect in his breathing apparatus: he cannot eliminate by his lungs the volatile empyreumatic product and the ammonia with the rapidity he should do: so these hang about his breath, and the skin doing more work than is natural to it, in order to relieve the lungs, the tobacco products pass off by it, saturating the clothing and concentrating the perfume. Thus one of our old herbal books says of tobacco: "It were a fine cure for asthmatics, did it not render them much more disagreeable to politeness than it doth other men who do attach themselves to it the more."

Every smoker is cognizant of the circumstance that there are times when he himself is more redolent than he ought to be, and of times also when his appetite for the weed is reduced to a minimum; and, if he inquire into the cause of this, he discovers it to be due to an arrest in some active secretion. He says usually in such cases that "his liver is out of order," which is a sufficiently uneducated way of speaking for the physiologist, but which conveys, nevertheless, to his mind a series of perverted functional changes that are now pretty well understood as indicating suppression of function in the lungs.

We thus account for the removal from the body of the volatile tobacco poisons; but what of the nicotine and the bitter extract? At the temperature of the body, nicotine cannot be considered a volatile substance, and the bitter extract is a soluble solid. Both of these substances enter the body by being carried along the stem of the pipe, combined with water, into the mouth, to be afterwards swallowed with the saliva. These, then, enter the body in solution, and so they leave it; they, I believe, are carried out entirely by the kidney, the grand eliminator of all poisons of the soluble type.

We sum up therefore, all that may be said respecting the "tolerance" of the poisons of tobacco smoke, by saying, that in the body accustomed to them they are removed, unless they be indulged in indiscriminately, or unless the body be diseased, nearly as rapidly as they are absorbed.

With the facts we have stated impressed clearly on the mind, we may follow out with reasonable understanding the effects of slow tobacco poisoning on the body. In brief, the effects are transitory; the influences exerted are functional, not organic. In the confirmed smoker there is undoubtedly a constant functional disturbance; his organs, *i.e.*, are doing work which is not essential to their duties, but they do it with moderate ease: they receive nothing that is deposited in their structure, and, let alone, they soon regain their natural condition. In the recognition of these simple truths, the whole gist of the tobacco controversy is enclosed; it is on the presence of the functional disturbance that the vehement anti-tobacconist bases his arguments; it is on the absence of organic mischief that the advocate of tobacco rests his defence.

We may turn at this point to consider, in detail, what are the functional disturbances to which the smoker is subjected. These are presented, with more or less of distinctiveness, in the blood, in the stomach, in the heart, in the nervous system, and in the glands of the throat and mouth. On the blood, the prolonged inhalation of tobacco produces changes which are very marked in character. The fluid is thinner than is natural, and in extreme cases paler. In such instances the deficient colour of the blood is communicated to the body altogether, rendering the external surface yellowish white and puffy.

The blood being thin, also exudes freely, and a cut surface bleeds for a long time, and may continue to bleed inconveniently, even in opposition to remedies. But the most important change is exerted on those little bodies which float in myriads in the blood, and are known as the red globules. These globules have naturally a double concave surface, and at their edges a perfectly smooth outline. They are very soluble in alkalies, and are subject to change of shape and character when the quality of the fluid in which they float is modified in respect to density. The absorption, therefore, of the fumes of tobacco necessarily leads to rapid changes in them; they lose their round shape, they become oval, and irregular at their edges, and instead of having a mutual attraction for each other and running together, a good sign of their physical health, they lie loosely scattered before the eye, and indicate to the learned observer, as clearly as though they spoke to him and said the words, that the man from whom they were taken is physically depressed and deplorably deficient both in muscular and mental power.

But with all this, it is marvellous to observe how quickly the blood will regain its natural characteristics on removal of the poison. One night's rest is sufficient to remove the evil, and restore the fluid to its natural state; the poisons fly, and nature rights herself.

The facts here given are derived from the direct observation of the blood of smokers in, I may say, every phase of poisoning by tobacco, and I believe they fairly represent the influence of the smoke of tobacco on the blood: but before I quit this subject I would point out that the effects produced vary exceedingly according to

the manner in which the tobacco is smoked. If the body is fasting, the effects are much more rapidly developed, and the fact is very important, as it accounts for the well-known circumstance that the majority of smokers fail to smoke easily on an empty stomach. Again, the effects are brought out with far greater intensity when the smoker indulges in a room the air of which is strongly impregnated with the tobacco poisons; and the reason of this is obvious, for under the condition named, the smoker is inhaling over and over again the finely distributed volatile matters with which the air is charged, while at the same time he is unable to throw off freely the products of his own respiration. Lastly, if a large quantity of fluid is imbibed during prolonged smoking, the changes in the blood are greatly increased, and are made to continue a longer time; for the fluids dilute the blood and dissolve and fix the poisons, and render their elimination more difficult.

CHAPTER IV.

THE EFFECTS OF TOBACCO SMOKE ON THE STOMACH AND HEART.

In the last chapter I pointed out that the slow effects of tobacco on the body are presented with more or less of distinctiveness in the blood, in the stomach, in the heart, in the nervous system, and in the glands of the throat and of the mouth, and I concluded by describing the specific action of the poison on the blood. In the present chapter I shall refer to the influence exerted by it on the stomach and heart. On the stomach, tobacco produces, even in the most confirmed smokers, marked deviations from the natural condition. Unconsciously, these smokers lose to a considerable degree their natural appetite. They feel, as it is said, that the pipe not only takes away hunger, but appears to sustain them in the absence of food. This is not mere fancy, for tobacco, as it impairs the oxydation of the body, also in proportion prevents waste. In so doing, however, it lessens the activity of all the organs, and therewith the organic power. The effects on the stomach are twofold,

and arise from two distinct poisons. Within, the stomach is lined with a delicate membrane, called mucous membrane, from which the gastric or digestive secretion is derived, and on the healthy structure of which good digestion depends. Outside to this mucous membrane, the stomach is surrounded with layers of muscular fibre, which in the act of digestion are in rapid motion, bringing the food mechanically into contact with the fluid that is to dissolve it. The influence of tobacco extends to both these structures. The bitter extract of which I have already spoken, and which so readily excites vomiting in the young smoker, appears to act at all times with more or less of violence on the mucous lining. At first it produces great irritation, redness, and injection; after a time the changes are subdued, but are not entirely removed. The membrane secretes irregularly, and, as a general rule, does not produce the due amount of gastric fluid; hence digestion is impeded. After digestion, acrid fluid is left in the stomach, which irritates and gives rise to heartburn, eructations, and frequent nausea, with almost constant sensation of debility of the stomach, sometimes attended with cravings for particular foods, especially those which have an acid reaction, such as pickles and fresh fruits. The muscular portion of the stomach is acted upon entirely by the nicotine. In small quantities, the nicotine excites a slight movement in the muscular fibres, not only of the stomach, but of the other parts of the alimentary canal; from which cause, in moderate smokers, tobacco acts as an aperient, and in this sense is sometimes even useful. Carried to excess, however, nicotine produces a palsied condition of the muscular fibres, leading to great increase of debility in the digestive organs, to a serious impairment in their functions, and to constipation.

Like the blood, the digestive organs, on being relieved from the pressure of the poison, quickly regain their activity; for there is no evidence to support the idea that an actual organic change of structure is produced in them. But inasmuch as they are the organs through which the vegetative life of the man is sustained, it must be admitted, that so long as they are functionally disturbed, so long the whole of the body, looking to them as it does for the sources of supply, is held, proportionately, in want and exhaustion; and if at the same time the waste were not, to a certain extent, prevented, that exhaustion would soon be increased even to danger.

I have already shown that nicotine and the bitter extract of tobacco travel along the stem of the pipe, are absorbed directly by the mouth, and are thence carried into the stomach by the act of swallowing. This is an important fact to bear in mind, as it explains the different degrees of action of different kinds of pipes out of which tobacco is smoked. A long, perfectly clean pipe, composed of a material like clay, which easily absorbs the two bodies specified, may be smoked even by the moderate man with partial impunity; but it requires a very confirmed smoker to tolerate the black dirty bowl and stem, charged to the mouthpiece with the more poisonous products; and in proportion as the toleration is borne, the digestion is sacrificed. Indeed, I do not believe it possible that any man can constantly smoke a foul pipe without being as constantly a martyr to extreme dyspepsia.

Again, different kinds of tobacco exert a different influence on the smoker, owing to the causes I have named. Some tobaccos, such as Cavendish, pigtail, and coarse shag, yield the fluid products to which I have drawn attention, in a much greater degree than Latakia or Turkish; hence the latter are called mild tobaccos; and although in smoking them they may produce dryness of the tongue, from the ammonia evolved, yet they do not upset the digestion materially, or nauseate, unless they are very indiscriminately used. Cigars, if they are "good," produce dyspepsia very quickly; for in smoking them, unless a long mouthpiece be used, nicotine is inevitably absorbed.

The influence of tobacco on the heart, has been very differently estimated by different writers. Some have conceived that its influence is entirely imaginary—others that it is most dangerous. The truth again lies, in this case, in separating functional from organic mischief. I do not think there is any evidence to show that tobacco alone is capable of producing structural change either on the valvular mechanism, or the muscular fibre of the heart; on the contrary, I believe that in persons strongly disposed to rheumatism and gout—diseases which arise from the presence and accumulation of acid matters in the blood—the tobacco, from its alkaline reaction, is rather a preventive to structural change in the heart than otherwise. I speak with diffidence on a subject which scarcely admits of demonstration; but yet I feel that I have had evidence and actual experience of the fact named. Once more; in persons who, either from necessity or ignorance, subject themselves to an unnatural degree of muscular exercise, and who make, as a consequence, egregious demands for labour on that pulsating organ which knows no rest; in such I believe the influence of a pipe daily (I do not mean of many pipes), is beneficial rather than otherwise. In these, the tobacco puts a curb on the extra excitement, and acting as a sedative on the heart, prevents its over-action, and arrests its excessive development.

Nay, strange as it may appear, I am inclined to believe that tobacco, instead of increasing the evil effects of alcohol on the heart, renders them less determinate; for alcohol tends to create fermentative changes in the stomach and alimentary system, and to give rise to those acid modifications of blood on which the more serious organic diseases of the heart mainly rest; while the tendency of tobacco is to stop these changes. Alcohol also excites the action of the heart; tobacco subdues it. Thus, if two men sit down together and take an equal quantity of spirituous drink, and if one smoke, and the other do not, the action of the heart will be much less increased in the smoker. I do not, of course, put this forward as an advantage, because it is very foolish for any one to take alcohol in excess; but I name the fact in its simple meaning, as a fact. So much for the influence of tobacco on the structural diseases of the heart; the rule varies when we turn to the functional derangements of the organ. There cannot be a doubt that inveterate smoking interferes very seriously with the contractile force of the central organ of the circulation. No one can observe the influence of nicotine on the heart, after its administration to animals, without feeling assured that nicotine imbibed from a pipe creates a paralysing effect, giving rise to irregularity of action, faintness, and sometimes to symptoms which, though not fatal, are for the time sufficiently alarming. I pointed out this fact some years ago, and it has lately been very ably commented upon by M. Beau. The conditions brought

about by tobacco in this way, come on, often suddenly, and last for many minutes, or even for an hour at a time. The symptoms are characterised by palpitation, a sensation as though the heart were rising to the throat, a feeling of breathlessness and of insupportable pain in the region of the heart; pain of a spasmodic kind also extends over the muscles of the chest, and occasionally to the arms, especially to the left arm. M. Beau has related a series of examples of the kind, and I can confirm his observations fully, although I have never seen death actually produced from this cause. My friend Dr. Edmunds has given me the particulars of a remarkable case of this nature, in which the attacks regularly followed every indulgence in prolonged smoking, and which subsided altogether when the habit was suspended. I presume that every practical physician, who is observant, has met with similar experiences.

But here again the symptoms induced depend on peculiar circumstances. To secure their development immoderate smoking is essential; and here too, the character of the pipe and of the tobacco used play important parts. The foul pipe, the strong tobacco, and the strong cigar, are the agents which tell most effectually and seriously. Further, there seem to be conditions of body which favour the action of the poison. When, for instance, the muscular system, including of course the heart, which is a muscle, is greatly fatigued or oppressed, as after excessive exercise or mental distress, or when, as M. Beau says, the secreting organs of the body are deranged, so that the nicotine cannot readily make its escape, and therefore accumulates in the blood, then paralysis of the heart more readily supervenes after indulgence in tobacco.

CHAPTER V.

THE EFFECTS OF TOBACCO SMOKE ON THE NERVOUS SYSTEM AND ORGANS OF SENSE.—VISION.

Writers against tobacco have dwelt with more than usual emphasis on the question of the influence of tobacco on the nervous system. They have presumed that from the use of this agent, Insanity, Paralysis, Epilepsy, and various minor maladies connected with the nervous system, result. I am inclined myself to the belief that statements to this effect are mere imaginings. They have been made without any reference to statistical facts; they have emanated from men who have been indifferently cognizant of the phenomena of disease; and have apparently been put forward, rather with the laudable but mistaken intention of alarming inveterate smokers, than of announcing any scientific induction.

At the same time, it is to be admitted that tobacco smoking does, when unduly indulged in, create disturbance in the functions of the nervous organs; for here the same rule obtains as obtains in respect to the stomach and the

heart; there is derangement, but not organic change. At all events, after looking most carefully into this question, from observations made on the ailments of smokers on the one hand, and on the causes of the symptoms manifested by persons affected by diseases of the nervous system on the other, I can come to no different conclusion from that drawn above.

The effects really manifested through tobacco on the nervous system, are of two kinds, or perhaps we may say, of three kinds, viz.:—*Sensual*, or those which are manifested through one or other of the senses; *Cerebral*, or those which show themselves through the brain itself; and *Nervous*, or those which are developed in the minuter portions of the nervous system, in the nerves proper.

In every case the symptoms presented are indicative of a low condition, of a deficient nutrition in the nervous structures. When the symptoms are exhibited through the senses, this fact is well marked. After long indulgence, if the eye be the organ influenced, there is a difficulty and obscurity of vision; in reading, for instance, the letters become confused and the lines dance, as it were, before the reader; sometimes, too, bright images appear, and small luminous specks float in the sight on looking into space. I have heard also, complaint made of deep-seated pain in the eye, particularly on looking at white objects, and I have even known dizziness and nausea produced by overstrained action of the eyes during this irritable condition.

In inveterate smokers the pupils usually are unnaturally dilated, and this dilatation increases during smoking.

This effect is due to the absorption of nicotine; for I have observed the same dilatation follow the action of nicotine simply. If the light is low, this dilatation of pupil produces but little embarrassment; if, on the contrary, the light is strong, vision is greatly impaired for the time; indeed, the light cannot be borne as in health. The influence exerted by the nicotine is directed in this case on the circular muscular fibres, by the action of which the aperture of the iris is closed. These fibres are, I think, paralysed by the nicotine in the same way that we have seen the muscular fibres of the stomach and heart paralysed by the same agent. On this, the radiating fibres by which the aperture of the iris is opened are allowed passively to contract, and the pupil or opening is unduly dilated.

But the symptom which of all others marks, through vision, the fact that tobacco is acting injuriously, is the long retention of images on the sensorium after the eye itself is withdrawn from them. I knew a smoker once who after long indulgence could retain a faint image of any bright object on which he looked for so long a period as six minutes after the eyes were closed upon it. If, for instance, he looked at the window in the daylight, the picture of the window was impressed on his retina and remained there in miniature, the panes of the window being filled up with what seemed to him red light, while the bars were dark. I have observed the same phenomena in my own person, not only after tobacco, but after experiments with nitrous oxide, and ether. If a bright light, such as a lamp or candle, be placed before the eye, the impression also is retained, but no image is retained that

has not a certain size and luminosity; letters of books are lost, as also are the minutiæ of objects which present many lines or figures. That the symptom here spoken of may arise exclusively from smoking is proved by the fact, that it begins and is intensified during the act, and gradually dies away as the cause is withdrawn. Whenever it appears, it is a good indication to the smoker that he has gone far enough, at least for that time.

If the observations I am about to make are correctly understood, I do not think there will be any difficulty in comprehending why the picture of an object should be retained in sight in the manner described. I shall have occasion some day to show that the retina of the eyeball is, in fact, virtually a photographic surface, and that the eye, as an instrument, is the same to its owner as the camera is to the photographic artist. Now, in health, when the oxydation of all the organs of the body is perfect, the picture formed on the retina is absorbed, or perhaps it were better to say, is transmitted instantly to the brain, where we may almost regard it as photographed again. When, however, from any circumstance, the oxydation or nutrition, or, in other words, the molecular motion of the retina is impeded, then the image is not immediately transmitted, but is held, as it were, on the surface for a time—gradually fading away.

In my experience I have not seen any worse results than those that have been named; but it is stated by some authorities that after inveterate smoking actual wasting of the nervous structure of the eyeball may occur, and that permanent blindness from the disease known as amaurosis may be the consequence. My friend, Mr. Wordsworth, who is one of the able surgeons to the Royal Ophthalmic Hospital, takes this view, and produces occasionally to his class, patients who, in his opinion, are suffering from "tobacco amaurosis." He adduced an instance of this kind on the 25th of March of the present year, in which case a strong man who had followed no kind of occupation likely to injure his sight, and who seemed to be in good health, was partially blind, owing, as Mr. Wordsworth thought, to inveterate smoking. This man, eight or nine years ago, commenced to smoke, and continued increasing the habit until he indulged in not less than half an ounce of strong tobacco a day. His pupils were widely dilated, the iris—the curtain for admitting or excluding the light—acted most imperfectly, and the discs of the optic nerve were partially wasted.

It would be a departure from, or rather a suppression of, truth, if I had omitted to state the conclusions at which Mr. Wordsworth has arrived, and it must be confessed that the instance he has given has a formidable aspect. The only answer I can make to it, is this: that as he seeing the symptom has traced it upwards to a supposed cause, I, after observing the effects of that supposed cause in an immense number of cases, have never witnessed the same extreme symptom; have never, in short, detected anything beyond functional disturbance in the vision of the smoker.

CHAPTER VI.

THE EFFECTS OF TOBACCO SMOKE ON THE NERVOUS SYSTEM AND ORGANS OF SENSE, CONTINUED.—THE SENSES OF HEARING, OF SMELL, AND OF TASTE.

From the eye we may turn to the ear as one of the other organs of sense assumed by some to be affected by tobacco. In respect to this organ and the modifications to which it is subjected in the smoker, the same rule, in my opinion, holds good as that which relates to the eye. I have no doubt as to the existence of functional derangement of the sense of hearing after long indulgence in tobacco, the change being manifested by certain well-marked phenomena, which phenomena usually attend, and are coincident with, the disordered state of vision and the general signs of indigestion which have already been described. The specific symptoms affecting the hearing are at first those of confusion and an inability to appreciate distinctly sounds that are either very soft or unusually loud. This inability gives rise to restlessness and uneasiness on the part of the listener, who often asks questions with respect to articulate sounds which to others present are perfectly and distinctly heard. After a short period, another symptom appears, viz., a sudden sharp ringing in the ears. This symptom will occur not necessarily during smoking, but at intervals afterwards. Sometimes, if attention be carefully paid to the subject, it may be discovered that some external noise, very slight in character—such as the ringing of a distant bell, or the whistling of the wind through a chink, or some far-off musical murmur—has produced the sound that is heard with so much exalted intensity by the sufferer. At other times, the symptom comes on apparently without any provocation; the man is reading, walking, eating, or is engaged in some amusement, when suddenly there darts through one or other ear, a sharp, shrill, drilling ring, which always seems to come from without, and lasts often for two or three minutes at a time. No pain attends this phenomenon, that is to say, no actual ache, although the annoyance is extremely great. Strangely too, the ear is not deaf during that time, for, if a watch be placed to it, the ticking is very distinctly heard; and still more curiously, both ears are scarcely ever affected at the same moment. If the symptom be very much prolonged, it may be attended with giddiness and nausea, but in the majority of cases, after running through three stages (a commencing, an intensified, and a declining stage), it abruptly terminates.

As regards the cause of this phenomenon, I trace it to the same source as that to which the impairment of vision may be attributed; it appears to me that, in these cases, the ear becomes highly susceptible of external impressions, and retains these much longer than is its wont in health; during the period of the phenomenon the tympanum, or drum, is undergoing a series of rapid vibrations,

which the irritable nervous expanse within the ear is absorbing, is retaining too long, and is transmitting to the brain too feebly. In plain words, the physical impressions made on the nervous expanse of the ear, like those which are made on the retina of the eyeball, are for the moment fixed so that they remain. If this be true, it follows necessarily that the sound is always, as it seems to be, from without; I mean, that something has occurred to set the air in vibration within the sphere in which sound can be heard, and that the intensified effect is due, not to any organic change in the structure of the ear, but to derangement and exaltation of the functions of that organ.

The same phenomena are met with under other circumstances. In the early stage of chloroform sleep, in fever, under the influence of haschisch and opium, persons experience strange sounds, compared by them to the sounds of a shrill whistle, of a railway engine whizzing briskly past them, or of a bell ringing sharply and near to them. To the bystander it may seem that these sounds are altogether formed in the mind, but if they are carefully noted in his own person by a careful experimentalist, it comes out that there is a cause for everything that is heard, and that the auditory sense has simply exaggerated an external sound.

In my experience I have never known the effects of tobacco to be carried beyond the extremes named; but here again it is but fair to state that other observers have, or think they have, seen much more extreme effects; thus M. Triquet has within the last few weeks called attention to a severe and indeed incurable form of deafness from paralysis, attributable to intemperance and the immoderate use of tobacco. According to this author, the person suffering from the malady described by him, is, in general, suddenly disturbed at night by a hissing sound in both ears, analogous to the tinkling of metal. This phenomenon decreases in the course of the day, but returns after meals, especially in the evening, and uninterruptedly persists throughout the night. The slightest noise causes pain, and even the suppressed murmur of conversation is distressing; the patient stops his ears with cotton, or with the tips of his fingers, not only in the street, but at home, in the midst of persons whose voices have long been familiar. This condition may last a few days or weeks, a month or two at most, and is immediately followed by the symptoms of the second stage, that of depression.

The subject congratulates himself at first upon what seems to be an improvement. The ringing has much diminished, and may even have entirely ceased. The distress occasioned by noise and sharp sounds is replaced by an opposite condition. The patient now seeks loud conversation, and complains that he is addressed in too low a tone. This deceitful amelioration lasts, however, but a short time, the last period of the disease is at hand, and sometimes suddenly, in the course of a night, the patient, to the surprise of all his friends, becomes stone-deaf.

This third, or paralytic stage, is the longest and most distressing, and—with some few exceptional cases in which, by timely medical interposition, some amendment is effected—the more or less complete abolition of the sense of hearing, which is the leading symptom, obstinately persists with all its evil consequences, cutting off the patient

from all social intercourse, and inducing a state of melancholy which occasionally leads to self-destruction.

This kind of deafness is not unfrequently accompanied by debility or perversion of some other organ of special sensation. Thus M. Triquet in such cases has often met with amaurosis conjoined with marked vascularity of the retina and optic disc; and although vision is not impaired in the same degree as hearing, it has, even in the young, lost a considerable amount of its power. Smelling is also more or less obtuse; a fact to be accounted for by the numerous communications existing between the nerves of these various organs. In some few instances, a marked diminution of the intellect, and vacillating movements in walking, indicate the propagation of the injurious effects of tobacco and alcohol to the brain and spinal cord.

In some instances, in addition to the symptoms already described, M. Triquet says that a purple redness is also present at the back of the throat, together with irregularly raised growths, small in character but giving a roughness to the surface; when these signs appear, the evidence as to the cause is, in his opinion, complete.

Respecting the theory thus advanced by M. Triquet, I believe that he has made but one error, which is, however, by the way, a vital one. He has mistaken *coincidence* for *cause*. I have seen precisely the same symptoms as those mentioned by him coming on in smokers in the same way, and running the same course, but I have seen them equally well marked in persons who have never smoked at all. They are as frequently found in women as in men, and perhaps more frequently. They may be induced or exaggerated by constant indulgence in alcohol; they may, perhaps, under such circumstances be increased by tobacco; but they may also arise from other causes, from great mental anxiety and over-work, from exhaustive diseases, from old age. When they are present, it will usually be found that the person who presents them has a feeble, unsound heart, and early symptoms of disease of the vessels of the brain. Hence the disease named is a general, as apart from a special disease arising from one particular cause; it may be presented in persons who do not smoke, it may be presented in persons who do smoke, and it may be absent in persons who smoke immoderately; surely, therefore, it is not fair, it is not truthful, to say that the malady is one of the direct evils consequent on the use or abuse of tobacco.

With the exception of the senses of sight and hearing, there is but little to be said further regarding the influence of tobacco on the sensual organs; it is probable, however, that after long smoking both smell and taste may, to a certain degree, be impaired. But the rule is not general, for I have known many confirmed smokers who have possessed the most keen olfactory sense—a sense infinitely more acute than in persons who had been unaccustomed to the pipe. The case is different in regard to snuff. It is not to be denied that constant snuff-taking does destroy, and sometimes completely, the sense of smell. I do not know that I can recall any one example in which indulgence in tobacco has produced paralysis in the nerves of taste. I have read of cases of the kind, but on inquiry have never yet met with them in fact; hence I am compelled to assume that they are either extremely rare, or that the statements regarding them have been based altogether on insufficient evidence. This remark applies also to the sense of touch.

CHAPTER VII.

THE INFLUENCE OF TOBACCO ON THE MENTAL FACULTIES.

From the organs of sense we turn naturally to the brain itself, and we ask the question: "Does smoking tend to produce cerebral disease and its train of consequences?" On this point we have had the most extreme statements on both sides. We have had it stated by those who oppose tobacco, that the luxury produces congestion of the brain, dulness and heaviness, softening, apoplexy, epilepsy, vertigo, chorea—St. Vitus' Dance—and various other serious evils. On the opposite side, these assertions have been most strenuously denied by able physicians and competent scholars. In like manner, as regards the effects of tobacco on the mental faculties, it has been asserted, on the one hand, that the drug stupifies, and makes all who play with it dull; while it is affirmed, on the opposite side, that it sharpens the intellect, and often enables the man of learning to solve difficulties which to him were before obscure. It was affirmed last year that in a military college in France, where there are two classes of students—one class that smokes, and another that does not smoke—the abstainers bore away all the prizes, and showed themselves to be by many odds the ablest workers. It was urged immediately afterwards, in opposition to this statement, that the Emperor Napoleon, whom some consider the ablest man in France, and who is certainly not wanting in a certain kind of perceptive and resolute thought, is a determined smoker, and on the Italian war-fields adhered to his cigar far more pertinaciously than to any other part of his equipment; and the labours of various eminent Germans have been adduced on the same side. At the last meeting of the British Association for the Advancement of Science, Mr. Reynolds advanced various views against tobacco, basing his objections mainly on the injury it inflicted upon the organs of thought. To him, the President of the Physiological section, Dr. Paget, retorted sharply, condemned the whole argument as unworthy of a scientific society, and asserted that in his course of life as a student, more particularly while he was a student in mathematics, he found over and over again the most difficult problems resolving themselves most easily under the genial influence of a pipe.

It is difficult at first sight, and indeed impossible without great consideration, to discover the source of these discrepancies; but when the subject is examined carefully, and without bias, the difficulties clear up, by learning that the extreme and exaggerated view entertained against tobacco, and to which reference has just been made, is, in truth, altogether romantic; it is based on no statistical evidence whatever, and rests only on the prejudiced induction—I beg pardon, I mean illusion—that because certain symptoms occur in persons who smoke, therefore

those symptoms are due to the tobacco and to nothing else.

Respecting the dangerous diseases of the brain which are said to result from smoking, we soon discover, on sound acquaintanceship with them, that the hypothesis entirely loses its ground. Taking apoplexy into consideration, we learn, in proportion as we become acquainted with the meaning of the term, that it is difficult to fix it as a disease, according to its original acceptation; and when one does trace it rigidly home, one discovers in it no kind of necessary connexion with the indulgence of the smoker. Looking back through a rather extended experience, I find that out of seventy cases where persons have died suddenly, as it has been thought from apoplexy, not more than nine—I refer now to individual observations—have really been proved to have been cases of true apoplexy; and of these nine, five were in women who did not smoke, three in men who did not smoke, and one in a moderate smoker; while amongst the hundreds of smokers whom I have specially examined, I have never seen a single individual who has suffered from apoplectic seizure. I cannot, therefore, for a moment allow that smoking, of itself, produces apoplexy; and without entering into any details, which would only tire the reader, the same general rule applies, according to my observations, to epilepsy and St. Vitus' Dance.

I cannot say so much in favour of tobacco when the disease called vertigo is mentioned. I have undoubtedly seen in examples of extreme indulgence, where there is confusion of vision and ringing in the ears, such as has been described, an accompanying symptom of giddiness and unsteadiness, which is commonly known under the name of vertigo.

It may be that this sign is dependent, to a great degree, on the aberrations of function in the organs of sense, and that the brain itself is not seriously affected. Nevertheless, I can conceive that whatever would influence injuriously the external and exposed portions of the nervous system, such as the surfaces of the retina, would in like manner affect the brain; and I would draw from this inference the practical rules, that whenever symptoms of giddiness follow smoking, the habit should be discontinued, and that whenever the same symptom occurs in persons who are not habituated to the pipe, the habit should not be acquired.

In reference to the question on which we have seen such divided opinions—the influence of smoking on the mental faculties—there is, I believe, no cause for obscurity. The facts lie in a nutshell. Tobacco, like all agents of its class, has the property of checking the oxydation of the body, and thus of diminishing waste. When therefore mental labour is being commenced, the system being well sustained, and the supply in excess of the waste, then indulgence in a pipe does produce in most persons a heavy dull condition which is difficult to throw off, because it stops the processes of assimilation and destruction, and thus suspends more or less that motion of the tissues which constitutes vital activity. But if mental labour be continued for a long time, until exhaustion is felt—until, in other words, the wasting of the corporeal power is greater than the supply—then the resort to a pipe gives a feeling of relief; it soothes, it is said, and gives impetus to thought; that is to say, it checks the rapid waste that is going on, and enables the mind to bear up longer in the performance of its task. The very same law applies also to physical or muscular exertion.

This explanation gives the key to the practical experiences of almost all smokers. Very few men indeed ever become so habituated to the pipe that they can commence a day of physical or mental work on a good breakfast and tobacco. Many try this, but it almost invariably obtains that they go through their labours with much less alacrity than other men who are not smokers; while the majority of smokers feel that after a day's labour, the resort to a pipe—supposing always that the practice is moderately carried out—produces temporary relief from exhaustion. Further, in many persons of great energy and industry, exertion, either mental or bodily, is often followed up so intensely that they cannot sleep, owing to the actual severity of the effort to which they have subjected themselves. They are excited, and are too tired for rest; the mind is chaotic and revolves rapidly over passing events, retaining nothing long, and dissatisfied with all. In this condition there can be no doubt that a pipe produces a soothing and even salutary effect, causing mental rest, a partial oblivion of the past, and leading to that natural sleep which is to "knit up the ravelled sleeve of care," and become "chief nourisher in life's feast."

Let it be understood clearly that I am not advocating the necessity of tobacco as a requirement of the natural life. I am open to the conviction that the excessive labours to which I have referred are altogether contrary to the natural laws of life. I believe that in this day we have run into the extreme of industry, have carried our exertions to the borders of insanity, and our competition to the extremity of folly: and so it is to be admitted that to the natural man such adventitious aids as tobacco are perfectly unnecessary; but our social exigencies daily override our philosophies; and as the individual man cannot by himself create a social revolution, he is too often bound to bend lowly to the stream, and seek in the unnatural conditions in which he is placed, unnatural, or perhaps under the circumstances I might almost say, natural remedies; for the most natural *remedies* are, in truth, unnatural measures, implying as they do in the necessity that calls for them, a primitive departure from nature.

For the reasons which have been stated above, it follows plainly, that tobacco smoking as a habit is most injurious both to the physical and mental organism in the early periods of life. Whatever may be said for or against tobacco, this is quite certain, that it should never be indulged in until the body is fully developed. During the early periods of life, when the youth is approaching to his manhood, all the physical and mental energies are at their full stretch to attain a certain maximum of growth and power. To throw obstacles, therefore, in the way of this development is necessarily to inflict on it a penalty which is life-enduring, and is never made up; and I do not think the anti-tobacconists are saying a word too much when they urge that the increasing indulgence by our children and youths in the use of tobacco is stunting the national growth, deforming the national life, degrading the national intellect, and establishing a race which must necessarily possess a limited force, and transmit its own degradation to the next and the next generation. If, indeed, there is one point upon which parental authority should be exercised, it is, I think, in forbidding the use of tobacco until the child has become a full-grown man and is capable of exercising his own independent and manly judgment.

There remains yet to be considered the question:—Whether the habit of tobacco smoking produces insanity? I believe there is no evidence whatever of the production of any form of insanity by smoking. If such a source of insanity existed, as is supposed, it would show itself immediately and broadly in the differences of numbers between the insane of the different sexes; the proportion of insane male patients would naturally be increased in proportion to the excess of males who smoke, over both insane males and females who do not smoke. But no such a rule is even approached: no special asylum has shown such a rule: no country, through its asylums altogether, has shown such a rule.

But apart from this general argument and statistical inference, we have corroborated evidence in individual experience. If tobacco smoking led to insanity, the fact could not have been overlooked, as it must have been, for ages by the members of the medical fraternity; yet how many of these, of unbiassed turn, could be brought forward who, excluding all other causes, could trace a single instance of any form of insanity back to indulgence in tobacco as the first and only cause?

Independently of other agencies, I believe that tobacco is utterly incapable of causing insanity; and common observation will endorse, I doubt not, this statement.

Still, it may be asked:—Does smoking not urge into activity a predisposition to insanity?

I have tried to examine this question fairly, and if I can arrive at any safe conclusion, it is that the damages committed by tobacco, in the examples under consideration, are fully, and even more than met by the advantages which occasionally follow. Certainly, in insanity attended with extreme excitement, and induced by over-exertion, I have seen a gentle and soothing influence produced by a pipe, which out-bade all narcotics, and acted as a valuable and safe remedy. Nay, even in melancholic conditions—when the mind wanders so rapidly from one thought and one determination to another that no impression is retained, and every act, from prayer to suicide, is done under such terrible impulse, that it is, as it were, performed together with the thought that prompted it—I have seen the soothing influence of tobacco exert, in a marked degree, a good effect. That it may be carried too far is easily and wisely admitted; that it may depress, by undue indulgence, and make matters worse than before, is also to be admitted; but any objection raised on this last-named fact ought, in fairness, to be allowed to extend to every act, however simple, that may be performed by the sufferer; to the exercise he takes, and the food he eats; for these, all-potent to cure, are all-powerful to destroy if unduly applied.

In relation to tobacco in its effects on the nervous system, I have only now to consider its operation on the nervous filaments themselves. The student who may not have paid close attention to the subject of the physiology of the nervous system, should be informed that, in addition to

the nerves of special sense, such as the optic, the olfactory, and the auditory, there are two other distinct systems in the body, the one known as the system of nerves of volition and sensation; the other as the system of nerves of organic life, or the sympathetic. The first of these sets have their origin from the spinal cord; they, through the spinal cord, put the extreme parts of the body into communication with the brain, and the brain into communication with the external parts. Thus, when we touch any part of the body, as with the point of a pin, sensation, or it may be pain, is communicated from the point touched, through a filament of nerve to the brain, or sensorium; when, again, the will directs the hand or foot to move, the direction is ordered, and the muscle, which is the moving organ, is bidden to move, through a volitional nerve from the brain.

The second system of nerves, the sympathetic, lies within the cavities of the body; the nerves extend from a number of small centres to the internal viscera, to which they are distributed. These nerves supply those organs of the body which work independently of the will, such as the heart and the stomach; they govern secretion also and excretion. Indirectly, they may be influenced through the brain; but, as a general rule, they act through forces conveyed to their own centres.

Does tobacco then exert any power over either of these sets of nerves? If it exerted any injurious action over the spinal cord, or the nerves arising out of it, the mischief would show itself in the production of external insensibility, or in disturbed action of the muscles, in convulsion or paralysis. If, again, it exerted any action over the sympathetic nerves, it would either cause increase or decrease of the functions and the secretion of the organs to which these nerves are distributed.

The fact is demonstrative that tobacco has the power of modifying the functional activity of both systems of nerves. The nicotine plays a very important part on the motor fibres of the spinal nerves, and probably on the cord itself. It excites through these structures muscular agitation, followed by temporary suspension of action, paralysis; and there can be no doubt that the blood could be made to absorb sufficient nicotine from burning tobacco to paralyse all the voluntary nerves.

In like manner, tobacco smoke has the property of acting on the sympathetic system of nerves, exciting them first to produce muscular spasm, to be followed by deficient power. It is owing to this circumstance that internal pain is produced, together with spasm of the stomach and vomiting, during the first attempts at smoking. It is from the same circumstance that the heart palpitates, and then becomes enfeebled. It is from the same cause, long-acting, that the organs of organic life become so sluggish and powerless in confirmed smokers.

But tobacco also exerts a temporary action through the sympathetic nerves over those structures which afford the secretions—the glands. Thus, in the early stages of smoking, it excites free secretion, probably, from all the glands of the alimentary canal; and in regard to the salivary glands, it retains this power in the individual often throughout life. Probably it similarly affects the pancreas, and the other glands lower in the digestive system. In ordinary smoking, I do not think anything important occurs except over secretion, at least in the majority of cases; but in

immoderate smokers the over-action may run into paralysis, and the secretions may become reduced instead of augmented.

Reviewing the whole question of the influence of tobacco on the organs of sense, the brain, and the nerves proper, the sum and substance of the argument is, that the mischiefs produced on these structures are transient and evanescent; the organs, that is to say, suffer only while they are under the influence of the poison; relieved from this, they recover their wonted activity with wonderful rapidity. We cannot have a better illustration of this fact than in what is daily observed in persons who during the act of smoking secrete a large quantity of saliva. So long as the nerves of the salivary glands are exposed to the action of the tobacco, the secretion poured out is profuse and uncontrollable; but so soon as the tobacco is withdrawn, the free secretion is stopped, and the gland resumes its duties in the natural order.

CHAPTER VIII.

EFFECTS OF SMOKING ON THE MOUTH.

I PROPOSE in the present chapter to touch briefly upon the effects produced by smoking on the structures of the mouth. This very important subject has given rise to repeated discussions and considerable warmth of argument. We will divest ourselves of all bias, and accept, as far as we can, the simple facts presented to us, as our guides to a correct conclusion.

It will help us in our inquiry if we take into consideration the structures in the mouth that are liable to injury. It will be remembered, in the first place, that along the edge of each lip there is a point where the common external skin, changing its character, becomes red in appearance, and smooth and bright. Let the eye be carried from the cheek to the inner surface of the lips and mouth, and the difference is at once detected. The real difference of these appearances lies in this, that at the commencement of the lips the ordinary skin of the body is slightly transformed in structure. Here too it receives a new anatomical name, *mucous membrane*. This membrane

is very much like to skin in its nature, and when washed, so as to be freed from blood, is nearly identical in appearance. It covers the surface of the mouth, and extends through the gullet to the stomach, and so on throughout the whole of the alimentary canal. It may easily be lifted up and removed, or may be torn, abraded, or ulcerated. Examined minutely, it is found to be made up of four layers; of a layer of fine scales called the epithelium; of a layer of firm and simple structure on which these scales rest, called the basement; of a layer beneath, known as the vascular layer, in which the nerves, blood vessels and glands are imbedded, and of a still lower layer of loose tissue for binding the membrane to the structures which it covers. The mucous membrane is well supplied with glands or secreting bodies. The ducts or open tubes of those glands which produce the saliva, pass through the mucous membrane into the mouth; while in the back of the mouth and throat there are numerous small glands, and other bodies known as follicles, which constantly supply some amount of secretion. Again, at the back of the mouth there are two bodies on each side, called tonsils, and a central structure projecting downwards, called the uvula. Nor must we forget in this summary of the parts of the mouth, the gums and the teeth.

What influence then has the smoke of tobacco on the structures named above?

In all cases there is excited in the young smoker an over-action of the glands of the mouth, and especially of the salivary glands. This over-action is felt only during the act of smoking, and in certain persons there is very little over-action even then. But, as is well-known, in the large majority of smokers there is set up a copious salivation, leading to expectoration, and to the employment of that very unsightly piece of furniture, which every housewife abhors, "the spittoon." We may leave the article of furniture, and the act which it suggests, as the only objectionable parts of the process; for I believe there is not a particle of reliable evidence to show that the salivation temporarily produced has any effect on the health. The argument has been, that as the saliva is necessary for the process of digestion, to divert it is to destroy, to a considerable extent, the power of digestion. The argument might be true if men smoked and ate at the same moment; but as this is impossible, and as in smokers generally there is, as a rule, an increased, rather than a diminished tendency to action of the salivary glands, it is not very easy to see how any loss of saliva during eating can occur from smoking. On the other side, if men must smoke, they are relieved by expectoration. It is commonly thought that men who do not expectorate, do not produce an excess of saliva; but the fact is, that the saliva, produced in the same immoderate quality, is swallowed by these last-named persons, and, taken into the system, is made the vehicle for the conveyance of those soluble but more fixed substances of tobacco, the nicotine and the bitter extract, which in physiological action are most pernicious.

One evil of a local kind does, however, sometimes accrue from the profuse flow of salivary fluid. The saliva contains, in solution, salts of lime, which, existing in excess, are liable to deposit, and to form hard stone-like masses in the ducts of the salivary glands, or to be laid down on the teeth in a calcareous layer, constituting the

crust called tartar. I have seen these results follow many times; but they are not necessary accompaniments, since they may be prevented by strict attention to cleanliness. The daily employment of a little pure vinegar in the water used for cleaning the mouth, and brushing the teeth, is, in truth, an effectual preventive measure against calcareous deposit and accumulation.

In respect to the smaller glands of the mouth, and the follicles, and the tonsils, an injurious influence is unquestionably exerted on them by tobacco. There is, in fact, a form of soreness of the throat—the disorder has been most ably described by Dr. Gibb—in smokers, which may be considered as peculiar to them. The disease consists of an irritable state of the mucous membrane at the back of the throat, redness there, dryness, a tendency to cough, and a large soft sore condition of the tonsils, rendering every act of swallowing painful and difficult. The state thus described is in no way to be considered as permanent when it has been excited, nor as universal amongst smokers, but it is occasionally difficult of cure, and it is far more general than is commonly known. I once examined the throats of fifty smokers, in order to determine the question, and I found in them the enlargement of tonsil so frequently, and the other appearances indicated so marked, that I think I could detect an immoderate smoker by this sign alone. It often happens, indeed, that the enlargement of the tonsils exists for a long time without giving any sufficient indications: but there comes on a damp, cold, foggy state of the air, and then the evil, becoming exaggerated, is troublesome and painful; enlargement of the tonsils is detected, and the annoyance is markedly increased by any attempt, however brief, to indulge in a pipe. In the fifty cases to which I have referred, thirty-seven had enlargement of tonsil.

In watching the progress of this disorder, which may very properly be called "the smoker's sore throat," it is observable that all the mischief is on the surface of the mucous membrane; it does not extend deeply into the tissues; it does not give rise to abscess, rarely to ulcer: it exists usually as an enlargement, with thickening of the mucous membrane, and profuse secretive action of the small glands, leading to soreness, exfoliation, actual mechanical difficulty in swallowing, and, it may be, to imperfection in speaking and singing. I have known it affect a public singer very seriously, producing a hoarseness, and a want of firmness that was most annoying and painful.

The "smoker's sore throat" is more easily induced by the use of cigars than of pipes. When once it is established in its acute form, it is quite incurable so long as the cause that excited it is allowed to continue; but it soon disappears when the cigar or the pipe is laid aside, and in respect to the body, generally, it leaves no dangerous symptom behind.

The mucous membrane, superficially, is also exposed to another change from very immoderate smoking. Its surface may be rendered dry, shining, and raised, and it may be made so irritable that when hot foods, or acid foods, are taken into the mouth they occasion a considerable degree of sharpness and pain. In extreme instances, the membrane, very much thickened, pale, and leathery, peels off in small roundish patches from the upper surface of

the tongue, leaving a red sore structure exposed. The remedy is to remove the cause, and that quickly.

On the gums, smoking produces two effects. It usually causes paleness and an undue firmness and contraction. Again in rare instances, where from the pressure of decayed teeth the gums are tender, smoking seems to induce vascularity and transudation of blood from them, with tenderness and swelling: but these are not the pure results of tobacco—they are aided by previous local mischief, and often by constitutional taint.

In some instances, together with the enlargement of the tonsils, there is elongation and soreness of the uvula. The cause here is the same, the course of the symptoms is the same, and the remedy is the same.

On the teeth themselves, setting aside the accumulation of tartar, I do not think tobacco smoke exerts any injurious influence. Nay, to speak fairly, I believe that the smoke has a tendency to preserve, rather than to destroy these important organs. It leaves upon them, truly, in unclean persons, a deposit of carbon which stains the white enamel black: but by virtue of its antiseptic action on acid and decomposing animal and vegetable substances, which so materially, by their presence, produce decay, tobacco-smoke counteracts much mischief.

Before leaving the subject now under notice there is one other all-important question to be considered, viz:—Does smoking produce cancer of the mouth? I must leave this point of inquiry for discussion in a special chapter.

CHAPTER IX.

DOES SMOKING PRODUCE CANCER?

The question placed above, owing to the weight that is attached to its proper solution, is deserving of consideration in a special manner. I have heard, as well as read, on this question opinions so wild and so extreme that I can scarcely hope to write in such a way as to gain no displeasure. In this dilemma there is, as Defoe has correctly suggested, no course before the writer but to proceed, irrespective of all censure, and to state the plain truth, whether it excite praise or blame.

The first observations that were made on the origin, real or supposed, of cancer, from the use of tobacco, were confined to those forms of the disease in which it appears in the lips. But after a time the assumed danger grew and grew, until it has become a fixed belief amongst a large section of the public, that cancer, in its general interpretation as a disease, may be produced by smoking, and that, in a word, the terms "tobacco" and "cancer" may be classed together in the order of cause and effect.

It is proper at once to break through this absurd fallacy, a fallacy which is singularly glaring from its marked opposition to all experience, past and present. For instance, the disease was present in Europe before tobacco was introduced as a luxury; hence the cause of cancer existed before the use of tobacco. But it is a law to which there is not an exception, that no disease can have *two* causes; so that if only one example of cancer were extant in a community previously to the introduction of tobacco into that community, the fact were decisive against the hypothesis of tobacco being a generic cause of cancer.

But we have further evidence in the experiences by which we are surrounded. We find the disease in the inferior animals, in all the domestic animals, and even in some which we might imagine would possibly be removed from it. Thus, Dr. Crisp has discovered the disease in the fish called the pike,—an animal which no enthusiast, surely, will ever accuse of going to bed on a cigar.

When to these facts we add this last, that as a whole, cancer is most prevalent in our own community amongst the members of the female sex, who, as a general rule, do not smoke, we require no further proof that tobacco must be entirely separated from cancer as the constitutional cause of that particular malady.

We will move next from the general to a special question. Can smoking excite locally—as in the lips, the tongue, or the throat—the disease cancer? The answer to this question must be indirectly in the affirmative; but to understand the position rightly, it is necessary to have a clear idea on certain points connected with the natural history of the disease altogether. I will explain these points as simply as I can without leaving the pure science in which they are involved. In a broad point of view, cancer is to be accepted as a local disease developed on a previously existing and general derangement of the nutrition of the body. Up to this time we have not the faintest glimpse as to the nature of this primitive departure from health, nor as to its cause. It is supposed that the blood has undergone some peculiar change, but the blood has been analyzed by the chemist and inspected by the microscopist without yielding any one result of an explanatory kind. Various causes have been assumed—varieties of climate, for instance, peculiarities of race, specialities of food, modified conditions of air, occupations, indulgencies in luxuries—but not one hypothesis has stood its ground under rigid investigation. Notwithstanding all this admitted ignorance, certain facts have been made out which are of deep interest. Thus it seems to be proved, that in about one in six instances of the disorder, it is transmitted, hereditarily, from parent to child. Secondly, it is made out that the disease is transmitted from the mother to the child very much more frequently than from the father to the child. Thirdly, it is known that the disease is prone to develop itself in certain particular organs of the body. Fourthly, that it takes, in its local manifestations, different forms, from which have arisen particular names, such as "hard cancer," "soft cancer," and the like, all of which forms rest on the same basis, but assume different appearances according to the part attacked, or the condition of the part at the period of the attack. Fifthly, it has been proved that, as a general rule, the disorder does not show itself definitely until the

victim of it is approaching middle age, although to this rule there are exceptions, sometimes extreme in kind; as for instance, one recorded by myself in a Fothergillian Prize Essay, where an infant was actually born suffering from cancer. Lastly, experience has taught us that when the disposition to cancer exists, it may be brought into full development at some particular part of the body by any cause that shall irritate that part so as to excite in it an over-active nutrition.

This last consideration brings us directly to the question whether smoking can light up in persons predisposed to cancer the active disease; if it can, it does it clearly by acting as a substance irritating the parts with which it comes in contact, the lips, the mouth, the tongue, or the throat: all other parts may be safely excluded.

From what was said in the last chapter, it might almost be inferred—theoretically, yet safely—that in persons of strong cancerous tendency the irritation produced by the smoking of tobacco would call into existence the local and much-dreaded mischief. But the truth is, that such occurrences are extremely rare, so rare in fact, that I can recall no instance where cancer, either of the tongue, throat, or cheek, could be connected with the use of tobacco. I have seen cancer of the tongue excited by friction of the tongue against a rough decayed tooth. I have seen cancer of the throat called forth by the irritation arising from the lodgement of a fishbone; and I have seen the tumour form and progress in these parts without any apparent reason; but I have never met with a single instance in which tobacco smoke could be said to have brought out the acute disorder. On the contrary, all examples of this kind which

I have seen, have, singularly enough, occurred in persons who did not smoke. If I were inclined to run into an extreme, I might indeed argue from the facts in my possession that the effect of tobacco was to stop the local change constituting the visible disease; but this argument would be unfair, because the experience of any one individual is too limited to allow him to speak dogmatically upon it. I content myself therefore with simply stating the fact that cancer of the mouth may occur, and does occur, in persons who do not smoke; that it does not specially occur in persons who do smoke; and that any extreme view in reference to tobacco as an exciting cause of cancer of the mouth, is without foundation.

There is still one other form of cancerous disease which deserves consideration; I mean cancer of the lower lip. The lower lip is affected, not unfrequently, in the predisposed, with a variety of cancer called from its spreading and superficial character "epithelial cancer." It has been observed unquestionably of this cancer that it occurs frequently in persons who smoke short pipes, and that it breaks out at that part of the lower lip where the pipe produces an impression. Here therefore we may, without hesitation, assume that smoking excites the cancerous disorder; but as I said some time since, this exciting cause is indirect in its action, inasmuch as it is connected with the pipe, and not with the tobacco; for it has been found by experience that the mischief does not become developed in cigar smokers, nor even in those who smoke pipes having a smooth surface, and which are of sufficient length, and as a consequence are cool—but that the accident happens mainly from the use of the short cutty pipe, which

is held very firmly in the lips without any support from the hand, and conveys to the lip considerable heat, amounting sometimes almost to pain.

Those who are opposed to tobacco will naturally accept the fact above given as a condemnation of the weed. Those who advocate tobacco, on the other hand, will assert that the statement, if true, tells nothing against tobacco itself, but simply against an objectionable way of using it; and I confess that this latter view of the subject is the one with which I should agree. Nay, I do not know whether something more may not be said even on the tobacco side of the controversy; for the truth is this, that whenever the pipe brings out the disease, as we have seen, there existed in the person affected a strong predisposition which would, almost to a certainty, have become developed in some one part or other of the body, if it did not break out in the lip. Under such circumstances the life of the sufferer will be considerably lengthened or shortened, according to the point at which the disease manifests itself; but if there is one point of the body more favourable than another for the development of cancer, it is the lip, and if there is one form that is more open to cure by operation than another, it is the epithelial cancer which occurs in the lip. Hence in the run of cases, it may rather be an advantage than otherwise that the cancerous disease should be thrown out at a spot where, for a time at least, it may divert the development of the fatal growth from more vital organs, and where, in extremity, it lies within the reach of treatment, and even of cure.

CHAPTER X.

DOES TOBACCO PRODUCE CONSUMPTION OR CHRONIC BRONCHITIS?

In the question proposed above, we have to consider a subject on which there are doubts amongst the learned as well as the unlearned; the wise and calm as well as the ignorant and over enthusiastic. Even while these papers have been in course of publication, a French practitioner, M. Mercier, has been commenting on tobacco as a cause of chest complaint, and lending the strength of his observations to the view, that incessant smoking has the power of producing bronchial irritation, and of keeping up a painful, troublesome, and even dangerous cough.* I have often heard medical brethren in this country adduce cases in which, as they believed, the first symptoms of *consumption* were observed to follow and depend on over indulgence in tobacco; and certain it is also, that I have been driven, by the force of repeated and, as it seemed to me, conclusive experience, to trace certain mischiefs, in individual examples, back to the use of the pipe or cigar; nay, I am morally sure that in many such instances, great and lasting good has been effected by forbidding a continuance of the luxury.

I am not inclined either, after what has to be told, to

deny that considerable damage may follow from smoking during certain peculiar conditions of system which have been brought on by other and more determinate causes; but I am at the same time obliged to express a doubt, after a rigid analysis of all the facts in my possession, whether smoking can be adduced as a prime cause of chest disease. I have been fortunate in having at command unusual facilities for conducting an inquiry into the precise relationships that exist between the practice of smoking and the presence of disease of the lungs. My position as a physician to the "Royal Infirmary for Diseases of the Chest," has given me the opportunity of instituting an analysis, such as has not before been attempted; and to this analysis I would now direct the reader.

The plan adopted in the collection of the facts, was very simple: the apothecary of the Infirmary was directed as he entered down the name, address, age, and duration of illness of each patient, to add to the record, in the cases of all persons, except children, the information whether they did or did not smoke. The apothecary had nothing to do in the matter of inquiry into the nature of the disease; that was left for me to determine; and as during the greater part of the time in which the investigation was carried on, I saw, by rule, only six new patients per day, I had leisure to make myself sure of the precise nature of each form of disease that came before me. The inquiry commenced on the eighth of October, 1860, and was continued for nearly three years: then I turned to the books and extracted the facts which they conveyed.

These books afford reliable data, and they tell us in respect to the two most prominent, and indeed the only two diseases of the chest that we need specially discuss—I mean Consumption and Chronic Bronchitis—the following series of facts.

In regard to Consumption:

There came under notice—

Cases to the total number of	361

Out of this total, there were—

Persons who did not smoke	225
Persons who did smoke or who had smoked	136

Thus out of 361 consumptive persons—

Those who did *not* smoke showed an excess of	89

Out of the total of 361, there were—

Males	230
Females	131

Out of the 230 males—

The number who smoked was	136
The number who did not smoke was ..	94

Thus out of 230 consumptive males—

The smokers showed an excess of ..	42

In regard to Chronic Bronchitis, including Asthma:—

There came under notice—

Cases to the total number of	475

Out of this total, there were—

Persons who did not smoke	338
Persons who did smoke or who had smoked	137

Thus out of 475 persons suffering from Chronic Bronchitis—

Those who did *not* smoke showed an excess of	201

Out of the total of 475 there were—

Males	249
Females	226

Out of the 249 males—

The number who smoked was	137
The number who did not smoke was ..	112

Thus out of 249 males suffering from Chronic Bronchitis—

The smokers showed an excess of ..	25

It suffices to read the figures given above, to feel that neither consumption nor bronchitis, in the chronic form, can be induced, primarily, by smoking; for while it is true that, amongst the men, those who smoke were the most numerous of the sufferers from both diseases, we are bound to accept this circumstance as coincidental merely. Had the persons whose cases were recorded been in health; had they been passing before a recruiting sergeant for entry into military service, for instance; there would have been a similiar comparison, in regard to numbers, between the smokers and those who did not smoke. We are obliged, consequently, to say simply, that amongst male sufferers from consumption and bronchitis, a majority indulge in smoking. Taking the whole of my cases, fifty-seven per cent. ranked as smokers, forty-three per cent. as not smokers.

But it would obviously be false to this question to let it rest solely on the statistics derived from one sex: women are as susceptible to the two diseases named as are men. Here then is a touchstone. Are women, who as a body are not smokers, and men who are not smokers, if placed together as one class, less subject to these disorders than men who are smokers? We turn to our tables and find that the combined class is *not* less subject, and that on the large scale the luxury of smoking does not come into the list of causes at all.

Smokers in general will doubtless breathe more freely after this exposition; but it would be unfair were they to be allowed to read these facts singly and unqualified. When it is said that tobacco is not a cause of the diseases to which attention is now being called, it is not also conveyed that when these diseases are once set up, tobacco does not aggravate them; or that when certain efficient causes are at work to induce these affections, that tobacco does not lend weight to the result. I am convinced it does both these things, and I could quote example upon example where persistence in smoking has tended to sustain and confirm the malady. This is most true in regard to consumption; for consumption is a disease which, with hereditary taint often lying at the bottom of it, is essentially a disease of bad air, a disease due to the long continued inhalation of an air containing an excess

of carbonic acid. It is a disease in which there is a deficient oxidation, and of necessity it is a disease that is intensified when the sufferer from it inhales, in the smoke of tobacco, carbonic acid itself, and not this alone, but various other gases, the action of which on the blood is similar in character. There is also another way in which tobacco does harm to consumptive persons: there is never any affection of the lungs, never any arrest in the process of breathing, without some derangement in the digestion. Indirectly, the stomach requires oxygen; and without oxygenated blood it fails to produce, freely, its digestive fluid: thus fresh air gives appetite. But smoking, as every one knows, if too much indulged in, destroys appetite and enfeebles digestion, and consumption does the same thing. In fact one of the most common presages of consumption is indigestion. Such indigestion, intensified by the act of smoking, adds trouble upon trouble, and hastens that destruction which the disease of itself is sufficiently competent to enforce.

For these reasons I have made it a rule for years past to insist on every consumptive patient yielding up the pipe or cigar; and I have found a rigid adhesion to this rule worth many a formal prescription.

In Chronic Bronchitis, the use of tobacco, in the ordinary run of cases, is also injurious. The smoke acts as an irritant to the irritable surface of the bronchial tubes; it keeps up cough, it increases indigestion, which in this disease, as in phthisis, and for the same reasons, is a troublesome attendant, and it stands constantly in the way of successful treatment. Like M. Mercier, I have seen many times, in persons who smoke, a cough following upon a cold, remain persistently until smoking has been suspended; then disappear as if by magic.

It is well, at the same time, not to be too dogmatic respecting the faults of tobacco in *all* bronchial affections. There is a spasmodic bronchitis, which is often called asthma, for which tobacco, by inhalation in smoking, is a useful palliative during the extreme paroxysm. I know an aged gentleman who, bordering on ninety years, has suffered from this spasmodic disorder for more than half a century. To him, tobacco has been a positive blessing, rendering his life endurable, and, as I think, prolonging it. But these exceptional cases are rare, very rare, and it would be foolish to stand up for tobacco smoking on them, seeing that the physician has in his repertory other means equally beneficial and not more objectionable.

CHAPTER IX.

SUMMARY.—FOR AND AGAINST TOBACCO.

In preceding chapters I have endeavoured to describe in detail, all the effects produced on the body by tobacco as it is used by those who smoke. Condensed into a few sentences, the details may be placed in the following summary.

1. The effects that result from smoking are due to different agents imbibed by the smoker: viz., carbonic acid, ammonia, nicotine, a volatile empyreumatic substance, and a bitter extract. The more common effects are traceable to the carbonic acid and ammonia; the rarer and more severe to the nicotine, the empyreumatic substance, and the extract.

2. The effects produced are very transitory, the poisons finding a ready exit from the body.

3. All the evils of smoking are functional in character, and no confirmed smoker can ever be said, so long as he indulges in the habit, to be well; it does not follow, however, that he is becoming the subject of organic and fatal disease because he smokes.

4. Smoking produces disturbances: (*a*) In the *blood*, causing undue fluidity, and change in the red corpuscles: (*b*) on the *stomach*, giving rise to debility, nausea, and in extreme cases, sickness: (*c*) on the *heart*, producing debility of that organ, and irregular action: (*d*) on the *organs of sense*, causing in the extreme degree dilatation of the pupils of the eye, confusion of vision, bright lines, luminous or cobweb specks, and long retention of images on the retina; with other and analogous symptoms affecting the ear, viz., inability clearly to define sounds, and the annoyance of a sharp ringing sound like a whistle or a bell: (*e*) on the *brain*, suspending the waste of that organ, and oppressing it if it be duly nourished, but soothing it if it be exhausted: (*f*) on the *nervous filaments and sympathetic or organic nerves*, leading to deficient power in them, and to over secretion in those surfaces—glands—over which the nerves exert a controlling force: (*g*) on the *mucous membrane* of the mouth, causing enlargement and soreness of the tonsils—smoker's sore throat—redness, dryness, and occasional peeling off of the membrane, and either unnatural firmness and contraction, or sponginess of the gums: (*h*) on the *bronchial surface of the lungs* when that is already irritable, sustaining the irritation, and increasing the cough.

5. The statements to the effect that tobacco smoke causes specific diseases, such as insanity, epilepsy, St. Vitus dance, apoplexy, organic disease of the heart, cancer, consumption, and chronic bronchitis, have been made without any sufficient evidence or reference to facts; all such statements are devoid of truth, and can never accomplish the object which those who offer them have in view.

6. As the human body is maintained alive and in full vigour by its capacity, within certain well-defined limits, to absorb and apply oxygen; as the process of oxydation is most active and most required in those periods of life when the structures of the body are attaining their full development; and, as tobacco smoke possesses the power of arresting such oxydation, the habit of smoking is most deleterious to the young, causing in them impairment of growth, premature manhood, and physical degradation.

If the views thus epitomized, in relation to the influence of tobacco smoking on individuals, are true, we are led without any difficulty to the consideration of the influence exerted by the habit on communities and on nations. That which smoking effects, either as a pleasure or a penalty, on a man, it inflicts on any national representation of the same man, and taking it all in all, stripping from the argument the puerilities and exaggerations of those who claim to be the professed antagonists of the practice, it is fair to say, that, in the main, smoking is a luxury which any nation, of natural habits, would be better without. The luxury is not directly fatal to life, but its use conveys to the mind of the man who looks upon it calmly, the unmistakeable idea of physical degradation. I do not hesitate to say that if a community of youths of both sexes, whose progenitors were finely formed and powerful, were to be trained to the early practice of smoking, and if marriage were to be confined to the smokers, an apparently new and a physically inferior race of men and women would be bred up. Of course such an experiment is impossible as we live: for many of our fathers do not smoke, and scarcely any of our mothers, and thus, to the credit of our women, chiefly, be it said, the integrity of the race is fairly preserved: with increasing knowledge we may hope that the same integrity will be further sustained: but still, the fact of what tobacco can do, in its extreme action, is not the less to be forgotten, for many evils are maintained because their full and worst effects are hidden from the sight.

Again, on the ground of the functional disturbances to which smoking gives rise in those who indulge in it, an argument may be used which goes very deeply, and cuts none the less sharply because, in one sense, it is ridiculous. Put down the smokers of Great Britain at a million in number—they are more than that, but let it pass:—Why should there exist perpetually a million of Englishmen, not one of whom can at any moment be writ down as in perfect health from day to day? Why should a million of men be living with stomachs that only partially digest, hearts that labour unnaturally, and blood that is not fully oxydized? In a purely philosophical point of view, the question admits of but one answer; viz., that the existence of such a million of imperfectly working living organisms is a national absurdity, a picture which, to a superior intelligence observing the whole truth and grasping it, would suggest a mania, foolish, ridiculous, and incomprehensible.

I cannot say more against tobacco, however, without being led into a wider question; I mean the use of luxuries altogether; on which question, if I were equally fair for tobacco as against it, I should be forced to give it a place as one of the least hurtful of luxuries. It is on this ground, in fact, that tobacco holds so firm a position:—that of nearly every luxury it is the least

injurious. It is inoccuous as compared with alcohol, it does infinitely less harm than opium; it is in no sense worse than tea or sugar; and by the side of high living altogether it contrasts most favourably. A thorough smoker may or may not be a hard drinker, but there is one thing he never is, a glutton; indeed there is no cure for gluttony and all its train of certain and fatal evils, like tobacco.

The friends of tobacco will add to these remarks, that their "friendly weed" is sometimes not only the least hurtful of luxuries, but the most reasonable. They will tell of the quiet which it brings to the overworn body, and to the irritable and restless mind: their error is transparent and universal, but universal error is practical truth; for, in their acceptation, tobacco is a remedy for evils that lie deeper than its own, and as a remedy it will hold its place until those evils are removed. The poor savage, from whom we derived "tabac," found in the weed some solace to his yearning vacuous mind, and killed by it wearisome lingering time. The type of the savage, extant in modern civilised life, still vacuous and indolent, finds "tabac" the time-killer; while the overworked man discovers in the same agent a quietus, which his exhaustion having once tasted, rarely forgets, but asks for again and again. Thus, on two sides of human nature we see the source of the demand for tobacco, and until we can equalise labour, and remove the call for an artificial necessity of an artificial life, tobacco will hold its place, with this credit to itself, that, bad as it is, it prevents the introduction of agents that might be infinitely worse.

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ON

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CONTENTS.

PREFACE.

The following little treatise has been prepared with the hope that by its aid any man of education may be able to become somewhat fully acquainted with the subject of smoky chimneys; to trace out the cause of any such nuisance with which he may be inconvenienced, and to apply to it its most appropriate remedy. It is also hoped that any practitioners who may have relied on some single scheme, as a cure for all disorders, will be able, on fully considering the various reasons why many chimneys smoke, to attain a more philosophical understanding of the subject, and, thereby, to give to their practice a more extended success. The recommendations, by the adoption of which smoky chimneys may, it is believed, be avoided altogether in new buildings, will, it is hoped, be made extensively known by the periodical press. An author's efforts without such aid can confer but the smallest possible amount of benefit on the public, and bring little or no satisfaction to himself.

49, *Great Marlborough Street,*
Nov. 9th, 1864.

A TREATISE ON SMOKY CHIMNEYS.

About seventy years ago smoky chimneys in England were so common an evil, that not only were there no houses without them, but the chimney that would "draw" well in all states of the atmosphere, without the temporary assistance of an open window, was exceedingly rare. Count Rumford appeared, and, in essays which have gained esteem for the author of them, wherever they have been perused, established rules for the construction of our fire-places, which have gained for us the very large amount of fire-side comfort we now possess. In the course of fifty years, a smoky or doubtful chimney has become the exception instead of the rule, and we can now wonder, that so long a period as a hundred and fifty years should have elapsed, from the time when coal became extensively used in domestic fire-places, before such simple and effective contrivances as those recommended by Count Rumford, were even introduced.

It will be well to make a general examination into the various causes why many chimneys entirely, and others on certain occasions, fail to perform their proper functions, and to endeavour to ascertain whether or not, by the application of indubitable and recognized principles, these may be reduced in number to a very small residue, with which, short of their reconstruction, it would be worse than idle for any one to interfere. By indicating also the errors of construction in the most difficult cases, we shall observe what should be avoided in the future.

It may be well to state, in a few words, how heat operates in our fire-places, to carry off smoke and other products of combustion. It is well known that when air becomes heated by radiation from the earth, or any other medium, it instantly expands and rises, cooler air filling its place to be heated in its turn, to expand and to rise. The upward passage of such air becomes arrested by its having gradually parted with its heat, and lost with it, its comparatively rarefied condition. In a closed building, the passage of heated air is arrested by a roof; so, also, in an apartment, by the ceiling; where, unless there are disturbing causes, the coldest air will naturally be near the floor, and the warmest near the ceiling. As soon as the air in a house or a room attains a temperature exceeding the external, there is a constant tendency for the colder air to enter by every, even the smallest, opening, and to displace the warmer and lighter air, which, as a rule, seeks higher points for escape. If a window be opened above and below, the quantity of air entering by the lower aperture will displace a similar quantity escaping at top, or by the chimney. If a door of a room be opened, where a fire is burning, a current of air rushing in at bottom may be observed with the aid of a lighted paper and a reverse current at top. If air is excluded altogether from entering the room, either by door or window, it inevitably enters by the chimney, provided only that the external air is colder, and therefore heavier and denser than the air in the room. The simple conditions upon which we depend, that there shall be an upward current in a chimney, are — 1st. That the air in the room is warmer than the external air. 2nd. That the external air has freer means of entrance to the room than by the chimney, viz. by the openings round a door or window, that the displaced air may find its point of escape at the chimney. It will be obvious

from this, that if houses are constructed so as to allow a free entrance to external air at many points, the chimneys will perform the office of channels of exit for rarefied air. If this is not attended to, or is intentionally frustrated, air enters by the chimneys. When a fire is made in an open fire-place, air becomes heated by contact with the burning fuel, and immediately rises, carrying with it smoke, carbonic acid, &c. If there is an upward current of air in the chimney, the products securely pass away. If, on the contrary, there is a down current, they are instantly emitted into the room. If there is no current at all, and the air is therefore stationary, the rise of heated air from a fire warms the air in the chimney, and an upward current is established, which is accelerated according to the degree of intensity with which the fire burns. The more the air in the room becomes warmed and rarefied, the more the external air rushes in by the doors and windows, and supplies that pressure of air from the room by virtue of which the ascensional current is maintained. If the general body of air in the room is allowed to become more rarefied than the general body of air in the chimney, air flows from the chimney to the room, bringing smoke with it. If, on the contrary, the air in the room is maintained in a less rarefied state than the air in the chimney, the ascending current continues. Having thus explained the simplest view which can be taken of the action of chimneys, we will enquire what are the disturbing causes which hinder them from performing their proper functions; in other words, why they sometimes smoke.

Cause 1.—From a fire-place being too open.

Cause 2.—From the doors and windows of a room being fitted too closely.

Cause 3.—From fires being lighted in two or three adjoining rooms, which are inadequately supplied with the air required by the grates in use.

Cause 4.—From a chimney being very short.

Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.

Cause 6.—From a chimney being exposed on two or three sides to the action of the external air, and the brickwork not being sufficiently thick.

Cause 7.—From a low chimney being in connection with a room adjoining a house or building in which the air becomes rarefied.

Cause 8.—From a down current in a fire-place bringing smoke from an adjoining chimney.

Cause 9.—From the top of a chimney being situated below a pitched roof.

Cause 10.—From the top of a chimney being situated near to a tower or similar source of obstruction to the wind.

Cause 11.—From a short chimney being enclosed on three or four sides by high contiguous buildings.

Cause 12.—From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.

Cause 13.—From chimneys of one house being lower than those of one adjoining.

Cause 14.—From a chimney being too small for the fire-grate used.

Cause 15.—From two fire-places being used for one chimney.

This appears to be a rather imposing list. It will be found, however, that some of the causes are so similar in nature as to be nearly identical, and that the remedies are, without exception, referable to very few and simple principles. Two other causes may be mentioned, which require no discussion; viz. that sometimes a chimney is found to be unsound, and, in consequence of a crack, admits a body of cold air; and, that a chimney which has given considerable annoyance, and puzzled many practitioners, has been found to have no other fault than that of having been accidentally stopped in some part by a mass of fallen brickwork.

Cause 1.—*From a fire-place being too open.*

Questions relative to the proper construction of fire-grates have been entered into at length in another treatise,* but some leading recommendations necessary for the proper elucidation of the subject now under discussion will be here reproduced. A fire-place more open than is necessary, for the most effectual use of an open fire, is the old evil so much combated by Count Rumford, and, even now, probably, the most frequent cause of a smoky chimney. Fig. 1 represents an old-fashioned grate with hobs, in which the Count's recommendations have been almost entirely disregarded. When a fire is lighted in such a grate, if there does not happen to be a good upward current in the chimney, an immediate effect produced by the rising of warm air is a rush of cooler air from the spaces over the hobs, which drives smoke into the room. If, however, the hobs are discarded, and if air from the room can, therefore, only press to the chimney directly over or between the fire bars, no hindrance from such a cause can prevent the proper escape of smoke. A farther inducement to discard such grates is that their form is very inappropriate for the effectual radiation of heat. The metal sides and back, *a*, *a*, *a*, receive a considerable amount of heat by conduction, which heat, however, they communicate to the currents of air which pass up the chimney and to the brickwork behind, so that the metal remains comparatively cool and radiates little heat. If, however, the back and sides of a grate are formed of fire-brick, which, being a non-conductor of heat, retains what it receives and therefore radiates it powerfully; if they are continued straight up from the fire, as shown in Fig. 2, and if the sides are placed at such an angle as to radiate in a proper direction the heat they receive,

* 'On the Economical Use of Fuel and the Prevention of Smoke in Domestic Fire-places, with Observations on the Patent Laws.' By the Author.

a fire will burn much brighter, and with far greater economy of consumption, than in a grate of the former description.

But, it is not merely necessary, on the score of efficiency and economy, to have a contracted *form* of grate. It is also necessary to provide means for contracting the opening into the chimney, and such means as can be used once a day, if necessary, without inconvenience. If no such means are provided, a considerable quantity of air, warmed by contact with the burning fuel and some heated parts of the grate, escapes at every moment freely up the chimney. The effect of such free escape of air is, that colder air rushes in by the doors and windows with much energy, and passes at once to the most rarefied part of the room, viz., to that in the neighbourhood of the fire-place, thereby creating disagreeable draughts. Many may suppose that a very free escape for air by the chimney is promotive of ventilation, and it certainly is so to a limited extent; but, it must be remembered that, when a fire is burning it is the coldest air, that which comes fresh from outside, which rushes with greatest force to the fire-place, and not the warm air of the room. A truly effective system of ventilation can only be obtained by other means.

It may also be said that a free escape of warm air up by chimney improves the current and effectually carries of the smoke. This is true, and it is well to make the current secure; but, if the upward current is much more than secure, we make a great portion of the coal burnt to answer a most unnecessary object, and we are inevitably inconvenienced by draughts of cold air. Fig. 2, and the section fig. 3, represent a grate with an improved register door or regulating valve, *c*, which can be opened and partially or wholly closed by a handle, *a*, in front of the grate. When a fire is lighted the regulator is generally fully opened. As soon as the coal is well ignited the regulator is closed about two-thirds. The handle, *a*,

should be of a non-conducting material, such as ebony, bone, or ivory, which could be used by any person without inconvenience.

Cause 2.—*From the doors and windows of a room being fitted too closely.*

Draughts of air are very unpleasant, and sometimes render small rooms almost uninhabitable in winter; but, the evil cannot be remedied by depriving the chimney of that pressure of air from the room which is absolutely necessary to prevent a down current. When we state that a fire burns, we mean that a certain quantity of air is becoming decomposed by the combination of its active element, oxygen, with the carbon and hydrogen of the coal, producing thereby heat and flame. The air for this object is taken almost entirely from the room, if there is no free ingress for air from other sources. Partly by this process, partly by the passage of undecomposed air up the chimney, and, partly by expansion from heat, the air in a room often becomes exceedingly rarefied, and if fresh air is not allowed to enter with some freedom, the air becomes in fact more rarefied than the air in the chimney itself. The inevitable consequence is that the air in the chimney being no longer supported by the pressure of air from the room, the balance becomes turned in the wrong direction, and air flows into the room from the chimney, bringing smoke and offensive vapour with it. The best chimney in the world may be readily made to smoke by the simple process of excluding the entrance of fresh air to a room.

By far the best remedy is to provide a special supply of air to the fire. This is commonly effected by means of a tube communicating with an external wall, and passing between the joists to some opening in the neighbourhood of the fire-place. The opening is sometimes in the hearth-stone, and is covered by an open grating, the bottom plate of the fender being pierced with a number of holes. At other times, the tube is carried behind the grate and the air is allowed to enter the room by openings at bottom near to the fire, as shewn at *b*, *b*, fig. 2. The latter arrangement may be considered to be the best, as dust and cinders are less likely to enter the open spaces than in the former. Many persons who have adopted the principle now suggested, have made the error of using tubes much too small. The tube should have an area of about the same as the opening into the chimney when the register or regulator is in its usual position, with a good fire burning. This should give about twenty-eight square inches for a room containing a thousand cubic feet of air, and four square inches more for every additional thousand cubic feet. A *little* more or less is not very material. If a surplus quantity enters to that required by the fire and chimney, air passes into the room; if a less quantity, a small demand for air is made upon the room. If it be considered impracticable to give a special supply of air to the fire, access must be provided by the usual means. If any one has to bear, however, with the inconvenience of draughts of cold air, it may be observed that the evil would be reduced to a minimum by the use of those grates which allow the smallest quantity of air to ascend the chimney. These are the contracted grates, with the regulating valve in the chimney, to which reference has already been made.

Cause 3.—From fires being lighted in two or three adjoining rooms, which are inadequately supplied with the air required by the grates in use.

This cause is similar to the last, but more complicated. When fires are burning in rooms immediately adjoining, and connected by a door, or folding doors, it is generally found that the ascending current from one fire-place is much stronger than from the other. For a short time, both fires may burn very well; but, when the air in both rooms becomes rarefied, a downward current ensues from the chimney of weaker

draught, bringing smoke and vapour. There are generally two ways of remedying the evil; the first, to reduce the quantity of air that can escape by the chimneys; the second, to supply more air to the rooms. The most judicious course, undoubtedly, is to see that the grates are so arranged, that they can abstract no more air from the room than is really necessary to support combustion, and maintain the effectual working of the chimneys—the means for accomplishing which have been fully explained in the last section, and in a former treatise. Though, in two badly arranged fire-places, the pressure of air from the rooms may be insufficient to prevent a descent of air and smoke in one chimney; directly the fire-places are improved, the amount of air which can pass up the chimneys from the rooms is greatly diminished in quantity; the air in the chimneys attains a higher temperature, and becomes, therefore, far more rarefied than before, and it is, consequently, easily upheld by the much less rarefied air in the rooms. The evil is of various degrees of intensity, and, frequently, the use of the regulating valve is all that is required; but, if the doors or windows are fitted very closely, a modification of the existing grates, or their substitution by others of better construction, will be insufficient to remedy the evil, and facility for the ingress of a greater quantity of air to the rooms must be given.

Cause 4.—From a chimney being very short.

An attic, or other short chimney, often smokes in consequence of the pressure of the atmosphere at the top of the chimney being greater in power than the ascensional force of heated air from the fire, so that a downward current ensues and turns back the smoke. Anything that will give a preponderating power to the upward current will remedy this evil. The heightening of the chimney, by means of a zinc pipe, is usually resorted to, as it is well-known that the ascensional current in a long chimney is generally much better than in a short one. This results from the well-known law that, when there is a difference of temperature between the air in the chimney and that situated externally, the air inside moves with a certain accelerated velocity, according to the length of the chimney. A long chimney does not, of course, absolutely create a current, but, as it is much less exposed to the cooling influence of the atmosphere than a short chimney, an upward current can usually be created in it, with very little difficulty, if it does not already exist; and, that current becomes, quickly, much more powerful than one in a short chimney, if other conditions are equal. Before deciding whether or not so unsightly an object as a lengthened chimney must be accepted as a necessary evil, we may enquire what other mode of improving the working of a short chimney, can be found to be effectual.

A law of very great importance in its relation to a fire-place is, that the greater the difference of temperature between two bodies of air, the greater is the velocity with which the lighter ascends, or is forced up by the other; or, in other words, the greater is its force. Therefore, the colder the air is in a room and the warmer the air is which rises from a fire, the greater is the force with which the warm air rushes, or is impelled into, the atmosphere. The air in rooms, with low chimneys, as attics, labourers' cottages, &c. does not commonly become very rarefied; the doors and windows in such places are not usually fitted with too much care to exclude air; they consequently do not suffer from an evil mentioned before, and the pressure of air below we may therefore assume to be usually sufficient. It has been shown before, that the effect of a contracted fire-place is to prevent currents of air from driving puffs of smoke into a room, and to give consistence to the column of heated air rising from the burning fuel.

It has also been shown, that a current becomes so accelerated in long chimneys, that such current requires to be checked. Now, if we apply these considerations to a short chimney, we shall see, that what is calculated to check the current in a long chimney, is useless in a short one, where a current is not easily attained at all; but, whatever is calculated to develope and increase the current in a long chimney, should be applied to the short chimney in a much greater degree. A regulating valve, where there is little or no upward current, and generally a reverse one, is therefore practically useless, unless it is possible for a good upward current to be established. It would therefore generally be left wide open. What is wanted is something of exactly the opposite nature; viz. means of establishing or increasing the current, and this is gained simply by an extension of the principle of contracting the fire-place. If, to a contracted grate, a sliding curtain or blower is used, as shown in fig. 3, an upward current is instantly improved if the fire is already burning. The reason why an extra contraction of the fire-place greatly increases the ascensional force of air from the fire, is as follows. By partly closing the space between the bars and the chimney, we reduce the amount of air that can readily find access to the chimney from the room, and the air in the space over the fire, which is temporarily closed in front by the blower, becomes highly rarefied. The warmer this space becomes, the more the air presses from the room into the chimney, and, as this air is obliged to pass in near contact with the fire over and between the fire bars, it attains a considerable temperature. The rush of air rapidly increases; the burning of the fuel is accelerated by the rapidity of the air; the fuel in turn acts with increased intensity in heating the chimney, and an upward current becomes thus easily established, where none before existed. Though, however, an upward current can, under very many circumstances, be created by such powerful means as a blower, the advantage is not gained without extravagance of consumption; little heat where it is most desired, and the use of a contrivance which might from inattention be greatly misused. A very great improvement, however, can be made by reducing the height of the fire-place. If the top of the opening is lowered to about twelve inches from the top bar of the grate a blower is less required. And it must be borne in mind that the only heat which can be considered to be lost by this practice is that radiated by the upper part of a grate, which is not considerable. Fig. 5 represents one of the abominable structures in metal with a large open space above, such as is commonly put into a labourer's cottage and into the attics of larger houses. Fig. 6 represents the same fire-place contracted, with the fire bars only of metal; with fire bricks to form the back and sides, and pieces of slate or other material to reduce the size of the opening. The former fire-place could seldom or never be used without the nuisance of smoke; the latter, with the aid of a piece of iron to cover part of the fire-place in front at the time of lighting the fire would, generally, of itself be a sufficient cure from smoke, and it is no figure of speech to say, that it would give about twice as much heat as the other from the same consumption of coal.

A short chimney can be further improved by reducing it in size. The less the size of a chimney, the less the quantity of cold air it contains, and, therefore, the more easily that air is heated, and the greater the force with which it moves. But, in reducing the size of a chimney, it is most important that ample space should be left to carry off a body of air, sufficient in volume to remove the smoke and offensive gases resulting from combustion. If the chimney be reduced to about the size of the fire itself, it will be more than sufficient, and, in a small room, nine inches by four and a half inches will be found ample.

To reduce the size of a chimney would be, however, rather a troublesome and expensive operation, and, it may be well, therefore, to point out how the object aimed at may be effected, in a considerable measure, by simpler means. Fig. 15 is a sketch of a metal tube, measuring in the upper part nine inches by four inches and a half, and in the opening below nine inches by seven inches and a half. If this be applied to a short chimney, just above the grate, and out of the sight of a person sitting, and if the opening to the chimney be closed so that no air can pass except through the tube, the lower part of the chimney will be effectually reduced in size, and the heated air will therefore have the consistence and force so necessary in a short chimney. If, also, the top of the chimney be reduced, by some very simple method, to the same dimensions as the small part of the tube, the chimney will become nearly as efficient as if reduced to the same dimensions throughout.

Fig. 15* represents an iron frame, with an opening of the same dimensions as the lower part of fig. 15, without its projecting rims, which could be built into the chimney. To this, the funnel-tube could be attached from below by means of turnbuckles, made to enter corresponding holes in the rims of the tube and the frame. This would enable the tube to be removed with facility for the purpose of sweeping the chimney or removing any soot that might fall around it.

It would be a troublesome matter to apply a regulating valve to the tube; and, as such an article would generally be practically useless, in consequence of there being no considerable current to be checked by it, its use might be dispensed with in short chimneys.

When a chimney is heightened considerably, it becomes immediately more serviceable. The down current becomes less intense, and can with greater facility be converted into an upward current; but, as a remedy, it cannot be depended upon alone. When a chimney is heightened by a zinc flue, for instance, which is the mode usually adopted, this flue is acted upon by the external air; and, when a fire is extinguished, the upward current is rapidly checked and converted into a downward current, which has, perhaps, to be reversed with difficulty the next time a fire is required. As, therefore, a heightened chimney is followed by uncertain results, and is generally very unsightly, it is far preferable to improve a short chimney by reducing it in size, or by reducing the apertures of ingress and egress; and, also, by giving such attention to the fire-place as will not only render it easy for an upward current to be developed, but will be followed by excellent results in warmth and economy.

Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.

Chimneys in London are usually built in party-walls, and are not therefore exposed to be cooled by the action of air except from the inside; but, a chimney in an external wall has exposed brickwork, which becomes damp and cold unless constantly defended by a heated current. As the thermometer falls, the exposed brickwork becomes reduced in temperature. It cools by contact the air in the inside, and as soon as such air becomes colder, and therefore heavier, than the air in the apartment below, a downward current ensues which becomes accelerated the more the cooling influence increases. Such a chimney may be improved by simply increasing the thickness of the brickwork on the exposed side. This is the most obvious, and, undoubtedly, the best remedy; but it is of course attended with rather considerable expense. The brickwork should be increased from

four and a half inches in thickness, which it frequently is, in such a position, to nine inches.

The next remedy is at the fire-place. As the difficulty to be encountered is exactly the same as in a short chimney, viz. to convert a downward current into an ascending one, it is equally essential that there should be reasonable access for air to the room, by doors and windows, and that the space between the bars and the chimney should be temporarily reduced by a blower to enable a body of air to become speedily warmed.

As in the former case, the opening of the fire-place may be reduced in height and the dimensions of the chimney itself may be reduced, or merely the two extremities. In applying the latter remedies, however, great caution is required. It is better that a chimney should be too large than too small, for, if the products of combustion cannot pass away with sufficient freedom, a portion will inevitably enter the room. The funnel-tube, fig. 15, will do very well for a small room, and it may be adopted on other occasions, simply by making it of wider dimensions throughout than nine inches. If, in any case, it be made a little less in width than the width of the fire chamber, so that it can be placed or removed without difficulty, and if the dimensions of four and a half inches above and seven and a half inches below be retained, there will in all ordinary cases be ample facility for the escape of smoke. It need hardly be mentioned that the particulars given are not of absolute necessity, and that the funnel-tube can be modified in a great measure according to requirement. It may be made of less height, and the sides may slope instead of being at right angles with the front and back, if such an arrangement will render it better adapted for the fire-place.

If the external chimney is from a dining room, or a drawing room, a preferable grate may be used to that shown in Fig. 4. In Fig. 8 is shown a grate known as Stephen's Patent. This has a very contracted form, but the contraction is behind the fire instead of in front of it. The current from the fire passes through a small door at the back of the grate, and, as the air becomes highly heated by passing over the burning fuel, an upward current can be quickly created and increased. The end gained is the same as by Fig. 4; but, there is this advantage in the Stephen's grate, that a good current is gained, at less cost, in consequence of the surface of the burning fuel, both at top and in front, being fully exposed to the room, even when the aperture to the chimney is most contracted. The door moves backwards and forwards on a hinge; but, in another grate, known as King's Patent, it moves up and down, being balanced by means of chains and weights. The latter description of door is most effectual for increasing or checking the draught. Both Stephen's and King's grates are admirable for several reasons. They give a very cheerful fire, look well, and they effectually warm large rooms; but, when properly made, they are more expensive than others, and they are not the most economical in use. The question, whether it is preferable to use such a grate, or to improve the construction of the chimney, can be decided immediately by reflecting that an upward current may not be created *instantly* by the grate, and that the aid of an open window may possibly be required, for a few seconds, in some instances; but, if the chimney be improved, it may become, practically, as useful as one situated in a party-wall, with which any well-constructed grate can be used. An external chimney in a wall facing the south or west is, for an obvious reason, less difficult to deal with than when the wall faces the east or north.

Cause 6.—From a chimney being exposed on two or three sides to the action of the external air, and the brickwork not being sufficiently thick.

This is an extension of the last evil, and the remedy is, therefore, a matter of greater difficulty. When a chimney is built in the angle of a wall, with two sides exposed, or against a wall, with three sides exposed, and when the brickwork is no thicker than four and a half inches, the case constitutes, frequently, one of the most inveterate smoky chimneys that are encountered. The contracted fire-place and a sufficient supply of air are indispensable, and the chimney can be reduced in size at each end; but, the only truly effective remedy is to reconstruct the chimney with nine-inch brickwork.

Cause 7.—From a low chimney being in connection with a room adjoining a house or building in which the air becomes rarefied.

This is a very difficult case, and generally comprises most of the ills of suffering chimneys. If, in public buildings, such as the Crystal Palace and St. James's Hall, there are apartments, or offices, with low chimneys, communicating immediately by doors with the main body of the building; whenever the air in this is more rarefied than that in the offices, air flows from the latter into the former as naturally as cold air enters a warm room by an open window. As the air passes from the room, colder air enters round the window and descends the chimney. We have in such a case a strong descending current, an external chimney, a low chimney, and one probably affected by wind, in consequence of its being below higher buildings, a cause which will be discussed further on. Every cause should be dealt with by itself. Air may be prevented from flowing into the main building by carefully fitted double doors. If the room be well supplied with air from special sources there will be a proper pressure to assist the upward current. The most contracted form of grate can be used. The external chimney and the low chimney can be improved by the means already indicated, and, finally, the descent of wind on the top of the chimney can be met by a simple protection. It will often be of lesser consideration to heat such places by means of hot-water pipes than to attempt the rectification of the fire-places and chimneys.

The same difficulty is often encountered in a private residence. A man builds an extra room at the back or side of his house, which he hopes to use for his dining room or library. He builds a short chimney, and when the air in his house is rarefied, cold air descends his chimney like a plummet, rendering it impossible for a fire to be used on most occasions. He should see that his house is reasonably supplied with air; fit his door of communication closely, or use a double door; give a special supply of air to his room; use a contracted grate; reduce the apertures of his chimney according to the instructions already given; heighten his chimney, if it can be done inoffensively, and place a protection on the top against the descent of wind.

Those intending to make such an addition to their houses in future, would do well to build their fire-place against their outside wall, and to construct a good chimney of the extreme height of their main building.

Cause 8.—From a down current in a fire-place bringing smoke from an adjoining chimney.

A descending current in a chimney takes place whenever the air in a house or room is more rarefied than that in the chimney itself, and, on smoke emerging from an adjoining chimney, it returns to the house in the down current. The evil is sometimes remedied by increasing considerably the height of one of the chimneys, not, surely, an agreeable sight. If the room be duly supplied with air, a downward current will be far less frequent, and may possibly never occur, when fires are in use; and, if the regulator be used, shown in Fig. 3, the chimney may at any time be carefully closed.

Cause 9.—From the top of a chimney being situated below a pitched roof.

In the previous sections, the difficulty to be encountered has been a down current in a chimney, but, we come now to a class of cases which are entirely different, and in which the obstructing agent is the wind. A pitched roof is a source of obstruction to the wind which strikes against it, and often rebounds upon a chimney situated below; or the wind, passing over the pitched roof in rushing to more rarefied strata of air on a lower level, strikes violently the ascending current of air from a chimney and drives it back with the smoke in spite of any protection there may be to the top of the chimney. An effectual remedy is to raise the height of the chimney above the obstructing agent. It is far better to do this by means of brickwork, which can be particoloured in ornamental buildings, and surmounted by an ornamental chimney-pot in earthenware, than to use a tube of zinc or other metal.

In modern dwelling houses, it is usual to build the chimney stacks very low, sometimes scarcely as high as the roof, and consequently all the chimneys are found to smoke a little when the wind is in such a quarter as to be likely to descend from the roof upon them. In this one particular, we have certainly not become wiser than our forefathers. The houses in Bloomsbury, for instance, have chimney stacks carried completely above the roofs of the houses, and the evidence of sight may convince us that they can have few smoky chimneys. If the builders of our modern dwellings will carry their chimneys sufficiently high we need never fear that we shall see them terminated by unsightly appendages.

Fig. 10 is a sketch of the roof of the Middle Temple Library. The pressure of air flowing over the high-pitched roof was often so great that the chimneys were practically useless, even with the fire-places well constructed. Ultimately, after a great deal of trouble, the chimneys were stopped above, and, metal flues, connected with them below, were carried up the sloping roof, as shown at *b, b, b, b*. Fig. 11 is submitted as exhibiting a reasonable suggestion for encountering the evil. By closing carefully the chimneys on the side nearest to the roof; by placing a simple protection at top, and providing a place of escape for the smoke on the opposite side only, it may be supposed that the smoke would escape without obstruction from any wind that may flow over the roof. If the wind is supposed to act in the opposite direction, as shown on the left side of the section, a shield, *c*, would probably be an ample protection.

Cause 10.—*From the top of a chimney being situated near to a tower or similar source of obstruction to the wind.*

This is another cause of an inveterate smoky chimney. A tower is usually an ornamental structure, but sometimes more ornamental than useful. If it is situated in close proximity to a chimney, this often smokes. The wind strikes the tower and rebounds on the chimney, or, if the wind comes from an opposite direction, and gains, by any means, a downward tendency, it prevents the smoke from emerging, as in the last case. The difficulty is often complicated by the chimney top being situated below a pitched roof, the chimney being in an external wall, and perhaps very short. Every cause must be, of course, dealt with. The fire-place should be treated in the manner found necessary for short chimneys; the thickness of the exposed brickwork should be increased, if insufficient, and the improvement can be considered admissible; the chimney should be carried above the height of the sloping roof, and, lastly, a protection, but of a very simple nature, should be furnished to the top of the chimney. The simplest and most obvious form of protection against a violent descent of air is a sloping

roof, as shown in fig. 12, which could be constructed of earthenware.

Cause 11.—*From a short chimney being enclosed on three or four sides by high contiguous buildings.*

Masses of cold air flow over the tops of our houses and descend into our streets and other open spaces. When there is a low chimney, as in the case stated, the pressure or force of the descending air is often so great as to overpower the upward pressure of the air escaping from the chimney, and a downward current ensues, totally regardless of any contrivance there may be on the top to prevent it. The evil may be most effectually remedied by building a chimney against an adjoining wall and carrying it above the roof. There may be a difficulty, however, in applying such a remedy, irrespective of expense; and, therefore, whatever means are calculated to improve the upward current may be used to diminish the evil. The due supply of air below, the contracted grate, the blower, the reduced chimney, the lengthened chimney within convenient limits, and the protection at top, will reduce the evil to a minimum that may cause annoyance at very rare intervals, if ever at all.

Cause 12.—*From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.*

When masses of air flowing from hills to lower levels strike the backs of houses, a portion of the air may rebound upon low chimneys of outbuildings, or the wind may descend directly upon the chimneys, and, if the pressure of the flowing air is considerable, a very powerful descending current sometimes ensues, rendering it quite impossible for a fire to be kindled. In such a case there can hardly be a choice of remedies, and the judicious course is to meet the evil at once, by building the chimneys against the back walls, of the extreme height of the main buildings. If, however, the chimneys are at some distance from the houses, the remedies for short chimneys can be adopted. The evil cannot, in that case, be of the utmost severity.

Cause 13.—*From chimneys of one house being lower than those of one adjoining.*

If the wind in passing over the roofs of houses strikes one of greater elevation, it rebounds upon contiguous chimneys that are below. In such cases a protecting roof to chimneys, as fig. 13 or 22, will be found indispensible.

Cause 14.—*From a chimney being too small for the fire-grate used.*

This is quite a modern cause for an ineffective chimney. Many persons have considered that our chimneys are too large, and, without considering the question with sufficient fulness, have unfortunately given dimensions for the construction of chimneys much too small. The best grate for a small chimney is that which allows the least air to escape, viz. the contracted description before referred to. But, if the chimney is too small for any ordinary grate, we may suppose of six-inch drain pipes, there is no remedy but to use stoves that require far less air than open fire-places, or to re-construct the chimneys of more suitable dimensions.

Cause 15.—*From two fire-places being used with one chimney.*

In ordinary fire-places, a considerable body of air passes up the chimney, and, when an opening is made in the chimney, and another fire-place is constructed, it is found that the chimney is not of sufficient capacity for the escape of the two columns of air. One of the fire-places is therefore useless, and smoke

returns to the room. The proper remedy is to diminish as much as possible the quantity of air that can pass up each fire-place by means of contracted grates, and the regulator shown in fig. 3, which should never be opened more than necessary for the free escape of smoke. A chimney that was only sufficient for one grate will thus suffice for two. It is also very essential that there should be no deficiency of air in both rooms.

A descending flue is often carried into a chimney which is required to answer another purpose; but to enter upon this matter would entail a discussion of the whole subject of descending flues, which should form part of a treatise on close or pedestal stoves.

On kitchen fire-places.

The last of the enumerated causes for a smoky chimney having been noticed, it will be well to say a few words on the application of the foregoing principles to kitchen fire-places. An old fashioned kitchen range, it is well known, has a large open fire-place, with a yawning chimney immediately over. Such a fire-place can be contracted in the manner shown in figs. 16 and 17. The openings above the hobs leading to the chimney should be entirely closed, and two upright pieces, *a*, *a*, fig. 17, shown by dotted lines in fig. 16, should confine the passage to the chimney at each side. A piece of iron, *b*, placed across in a sloping direction, and fastened at each end to the two side pieces, will act as a check to the quantity of air that can press to the chimney from the room. The air in the chimney would become in consequence far more rarefied, and the air which passes over the fire and enters the chimney, would have, therefore, far greater ascensional power than before. A blower, *c*, will assist to contract the open space, and if an opening, *d*, be left at the top of the sloping plate, any smoke rising directly from the fire will readily escape.

A kitchen is usually abundantly supplied with air, but, there is an impediment peculiar to such a place of very common occurrence. Our builders are generally judicious enough to provide our kitchens with chimneys of sufficient capacity to carry off the considerable quantity of warm air which we discharge into the atmosphere; but, it is no uncommon thing to find that the escape of the air and smoke is checked by a very small chimney pot being used, as a fitting termination, to a large chimney. The upward force of the air being greatly checked, the external cold air often prevails, enters the chimney and drives back the smoke. A chimney pot to a kitchen should not be less than twelve inches in diameter in the inside.

The article termed a kitchener, now very commonly used instead of an old-fashioned kitchen range, has become very well known within a few years. The upper part of the fire-place is entirely closed, and the usual passage from it to the chimney is by flues round the oven and boiler. The kitchener is scarcely ever known to smoke, even with a very low chimney, which is to be accounted for by the fact, that it sends so considerable a volume of highly heated air into the atmosphere, as to overcome by its force any pressure of an opposite nature. This extravagant mode of rectifying a defective chimney pronounces strongly against our economy of heat in kitchen fire-places.

Mr. Billing's Terminals for Chimneys.

This little treatise would be decidedly imperfect without an examination of the mode of finishing the tops of chimneys which was introduced by the late Mr. Billing, and which has been of late somewhat extensively applied. Fig. 20 represents a piece of earthenware, which is placed at the top of a chimney for the purpose of considerably reducing the aperture by which the smoke can escape; and fig. 19 another piece of earthenware, used to form a division between two chimneys, or to enclose a chimney on two sides. Both articles are shown in position in fig. 21. In fig. 18 the division piece, a little different in form to fig. 19, is seen to terminate the chimney stacks, the ordinary chimney pots being, of course, dispensed with. The author is not aware what is the real nature of the benefit claimed to arise by the use of these simple contrivances, and he will, therefore, endeavour to examine in what way they appear calculated to affect, or to improve, the action of a chimney.

It has been seen that when a downward current exists in a chimney, and smoke issues from one adjoining, that this smoke occasionally passes into the downward current, and descends to a room where there is no fire burning. It has been pointed out that the evil can be remedied by supplying the room in which the nuisance occurs, a little more freely with air, that the descending current may be checked, or converted into an upward current; and, that a convenient and effectual means of closing the chimney may be of service on such an occasion. The evil may, however, be met by such a contrivance as fig. 19. If this division piece be placed between two chimneys at top, the air and smoke issuing from one will pass off at the sides which are not blocked, and a descending current in an adjoining chimney will, with considerably less probability, carry smoke with it. But, returned smoke in a vacant fire-place is not a common evil, and, as the other means indicated for avoiding it are such as improve the condition of habitable rooms and the effectual working of a fire-place, they may be considered the preferable. The division piece may answer, however, a more useful purpose. No chimney stack can be left with a flat surface at top. The old chimney pot had its use in breaking the force of the wind, and, if the division piece is found to answer the same purpose as effectually, it may be used as a substitute for an old form.

The first effect which a reduction of the aperture at the top of the chimney, by fig. 20, appears calculated to produce, is to check the ascent of the heated column of air. That it does so, may be considered evident from the fact, that a partial closing of the regulator or register in the fire-place, checks the quantity of air that can enter the chimney. In a water pipe or a gas pipe a check of the same description greatly diminishes the force and quantity of the issuing air or liquid. At the top of a chimney the same causes operate as at the bottom, though different in degree. There is the air expanded by heat, the pressure upwards from below, and the resisting medium above; and, there appears to be no other difference between the check at the top of a chimney and the one at bottom, than that the former is permanent, but that the latter can be used or not at pleasure. As, however, it has been shown that it is often advisable to establish an upward current in a fire-place with some rapidity, for the purpose of effectually carrying off the smoke, which current should be diminished as soon as the object has been gained, the check to be used or not at pleasure may be considered preferable to the permanent one.

There is, however, another aspect of the case. Are our chimneys of the most useful dimensions for performing their office, or are they invariably too large? If they are too large, is it not useful to diminish the size at top, for the purpose of preventing as much as possible the entrance of cold air, and to offer as small a surface as possible to the action of the wind? The only answer to this question must certainly be in the affirmative; but, anything more than this simple admission should entail a discussion of the whole subject relative to the best dimensions for chimneys. This can be more properly dealt with in a treatise addressed particularly to our architects and builders; but, it will be sufficient for our present purpose to remark, that the dimensions of a chimney should necessarily correspond to the quantity of air it is required to remove, which again depends on the size of the fire and the description of grate in use. As our chimneys are almost universally of the same dimensions, it follows, that what is sufficient for one apartment is much more than sufficient for another. A chimney from a small fire, with a contracted grate, may be greatly reduced; but, one from a large fire should be dealt with very cautiously. We may therefore consider that the article, fig. 20, is of benefit in all cases when the aperture is fully sufficient to remove the heated air, gases, &c. which may at any moment be ready to escape. If, on the contrary, it be used at any time with an aperture insufficient in size, the checking of the upward current will enable the pressure of the air above to prevail; cold air may enter the chimney and the products of combustion be driven back. The contrivance, therefore, should be used with caution to existing buildings; but, with reference to buildings yet to be constructed, demonstration is hardly necessary to prove, that its use should be superseded by the chimneys being constructed of the dimensions which are best adapted to answer their intended purpose.

We may now ask whether or not the division plate and a reduced aperture can serve a purpose of protection against wind. It has been, we hope, amply proved that chimneys only require such protection when their tops are below something contiguous and of greater elevation, by means of which a descending power is given to the wind. If we look at the sketch, fig. 21, it will hardly appear that the division plate can often protect the aperture for the smoke. What is wanted in such a case is a simple roof, as in fig. 22, which was put to a house in Park Village, Regent's Park, on its construction many years ago.

Concluding Observations.

The above causes probably account for ninety-nine per cent. of all the smoky chimneys that exist, and, it is doubtful, indeed, if there be any other that is not almost identical with some one of those described. It will now be evident to any person unversed in such matters, who may have given the preceding observations a little careful consideration, that the idea of there being any universal cure for a smoky chimney is very preposterous, and can only have arisen in the minds of those who have not pursued any investigation upon a scientific basis, or whose experience in such matters has been of very limited extent. Though, however, the causes for a chimney smoking are various, they all proceed from a disregard of general principles very few in number. For the sake of perspicuity, every distinct cause has been stated and examined by itself, and it is hoped that the particulars given are sufficient to indicate what are the very few cases of real difficulty, and to enable a person of intelligence to decide upon, and to apply, an appropriate remedy in any instance in which he may happen to be a sufferer. Though, however, the distinct causes are numerous, and the remedies various, it may be shown that the whole question is involved in very great simplicity.

The fifteen causes mentioned may be placed under three divisions, as follows—

First Division.

Chimneys that smoke in consequence of a descending current existing, or being produced in the chimney.

CAUSES.	REMEDIES.
Cause 1.—From a fire-place being too open.	To contract the size of the fire-place, or use a contracted grate.
Cause 2.—From the doors and windows of a room being fitted too closely.	To supply air by means of doors and windows, or by means of a special supply near to the fire.
Cause 3.—From fires being lighted in two or	To contract the opening into the chimneys.

CAUSES.	REMEDIES.
three adjoining rooms, which are inadequately supplied with the air required by the grates in use.	To give an additional supply of air. To use grates that will not allow much air to ascend the chimneys.
Cause 4.—From a chimney being very short.	To use a contracted grate with a blower. To reduce the height of the fire-place and the size of the chimney. To lengthen the chimney. To reduce the opening into the chimney at bottom and at top.
Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.	To improve the construction of the chimney. To use a very contracted grate. To reduce the opening into the chimney at bottom and at top.
Cause 6.—From a chimney being exposed on two or three sides to the action of air; the exposed brickwork not being sufficiently thick.	To improve the construction of the chimney.
Cause 7.—From a low chimney being in connection with a room adjoining a house or building in which the air becomes rarefied.	To supply the house and room liberally with air. To fit tightly the door of communication, or use double doors. To use a contracted grate. To heighten the chimney. To reduce the size of the chimney.
Cause 8.—From a down current in a fire-place bringing smoke from an adjoining chimney.	To supply the room properly with air. To use a carefully fitted regulator to the chimney.

Second Division.

Chimneys that smoke in consequence of a descent of wind.

CAUSES.	REMEDIES.
Cause 9.—From the top of a chimney being situated below a pitched roof.	To heighten the chimney that its top may be above the source of obstruction.
Cause 10.—From the top of a chimney being situated near to a tower, or similar source of obstruction to the wind.	To heighten the chimney. To use a simple protection, as fig. 12.
Cause 11.—From a short chimney being enclosed on three or four sides by high contiguous chimneys.	To heighten the chimney. To put a simple protection at top. To use the most contracted grates, and supply air below in moderate abundance. To reduce the size of the chimney or the extremities.
Cause 12.—From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.	To build the chimneys of the extreme height of the main building. To use the remedies indicated for cause 4.
Cause 13.—From chimneys of one house being lower than those of one adjoining.	To heighten the chimneys. To put a protecting roof, as fig. 13 or 22.

Third Division.

Chimneys that smoke in consequence of their being too small.

CAUSES.	REMEDIES.
Cause 14.—From a chimney being too small for the fire-grate used.	To use a grate that will allow a minimum quantity of air to ascend the chimney. To re-construct the chimney. To use a stove.
Cause 15.—From two fire-places being used to one chimney.	To use well-contracted grates, with carefully fitted regulators. To supply rooms sufficiently with air.

It is seen by the above table that nearly all our smoky chimneys are occasioned by two general causes, viz. the natural descent of cold air in a chimney, and the fall of wind on the top of a chimney, caused by some neighbouring obstruction. The third general cause is very rarely encountered. We can now make some interesting reflections relative to the mode which has usually been adopted for the prevention of nuisance by smoke. What has been a source of perplexity to thousands, nay hundreds of thousands of persons, has simply been, that they have entirely confounded the first general cause with the second, both being, in fact, entirely distinct, and to be encountered by different remedies. If the natural descent of air in a chimney be reversed by some of the various means indicated, the wind itself will be found to be, by no means, the difficult subject to deal with that is generally supposed, and the thousand various forms which have been invented to wile away, or to protect against, the wind, may, to the benefit of the national taste, pass quickly into oblivion. A few of the amusing forms, however, will be preserved in the pages of the lamented Mr. John Leech, where he gives his celebrated Mr. Briggs amazed and delighted at his builder's operations on the roof of his house. We have seen that chimneys are only affected by the wind when they are situated below something contiguous, as a roof, a neighbouring stack of chimneys, a higher house or neighbouring hills, and that, therefore, chimneys in general do not require any protection whatever. It can, in fact, be proved, by overwhelming evidence, that when bodies of air move unobstructed over our heads on the same plane as the horizon, they do not affect our chimneys in any appreciable degree. We have only to look around us, and we shall see that the number of chimneys to which it has not been considered necessary to apply a protection, is by far the most considerable, and that, in many recent buildings, no trace whatever of such a thing is to be found. Fig. 18 represents a portion of the roof of the National Provident Institution, from the designs of Professor Kerr, in which the chimneys are raised high, as they should be; and fig. 14 the roof of Montagu House, Whitehall, in which the same precaution has been taken. A most excellent example is the Charing Cross Railway Station and Hotel now being completed.

Recommendations to builders and others for the avoidance of smoky chimneys in new buildings.

Rule 1.—To use grates of a contracted form, fitted with proper regulators, and to avoid grates with hobs.

Rule 2.—To avoid fitting doors and windows so as to practically exclude fresh air from a room; or to give a special supply of air near to a fire, in sufficient quantity, for which particulars have already been given.

Rule 3.—To build chimney stacks in all cases as high as the highest part of the roof, and to terminate them by chimney pots, or by Mr. Billing's division piece.

Rule 4.—To terminate a chimney stack by a projecting roof, as fig. 13 or 22, whenever a building is lower than an adjoining one, or whenever the chimney

stack of one house is lower than a contiguous one of a house adjoining.

Rule 5.—To build all chimneys that are exposed on one side, or more, of nine-inch brickwork.

Rule 6.—To build all short chimneys of smaller dimensions than usual. Nine inches by four and a half inches are sufficient for ordinary attic fire-places and labourer's cottages.

Rule 7.—To construct the fire-place of a low chimney not exceeding thirty inches in height.

Rule 8.—In constructing an extra room with immediate communication from the main building: to build a good chimney, if possible, against the main building, and terminate it as by Rule 3.

Rule 9.—When it is impracticable to build a lofty chimney against the main building, to construct the chimney no larger than amply sufficient: to use a contracted grate, with a blower; to build the chimney as high as may be convenient; to construct a low fire-place; to give a special supply of air near to the fire; to place a protecting roof to the chimney; and, if the air in the house or building is likely to be generally more rarefied than the air in the added portion, to fit tightly the door of communication, or construct a double door. The last two rules are intended to avoid the causes 7 and 12.

It may be hoped it is now obvious, that by attention to such general rules as the due supply of air to houses and rooms; the use of contracted fire-places; attention to the proper construction of chimneys, and the use occasionally of some simple protection, smoky chimneys may be everywhere successfully dealt with, and rendered very unnecessary possibilities in the future. May it not also be considered evident, that elegance or neatness of form, need never be sacrificed to utility, and, that, if excellent designs are often marred by unsightly terminations to chimneys, this is simply in consequence of two important subjects being unequally understood? None will be more thankful than our very useful body of architects to be relieved from unsightly nuisances; and, if, with minds already considerably practised on the subject, they should have their attention directed to these pages, the author's labour will not have been in vain, and he will have reason to be thankful that certain fortuitous circumstances have given him an opportunity to render one slight service to his country.

The question of the ventilation of our apartments, together with the utilization, to a considerable extent, of the heated products of our fires, and the most efficient construction of our chimneys, the author will, with much probability, discuss at a future period. He hopes to show that a true and effective system of ventilation need not interfere in the slightest degree with the due warming of our apartments, and, that, the more both subjects are understood, the better they can be harmoniously combined.

Fig. 1. An old-fashioned grate, made entirely of metal, with large space over the fire.

Fig. 2. A contracted grate: *a*, *a*, *a*, fire brick back and sides; *b*, handle of regulator to chimney opening; *d*, opening to admit fresh air.

Fig. 3. Transverse section of fig. 2: *a*, *a*, *a*, fire brick chamber; *b*, handle of regulator to chimney opening: *c*, regulating valve in chimney.

Fig. 4. Contracted grate with a sliding blower, *a*. The outer form shown in figs. 2 and 4 is not necessary. The more popular arched form for a grate is equally serviceable to contract the opening of the fire-place.

Fig. 1.

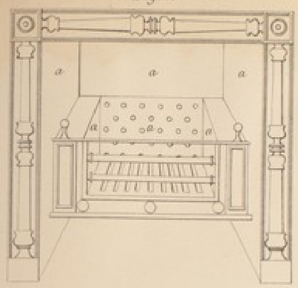


Fig. 2.

Fig. 3.

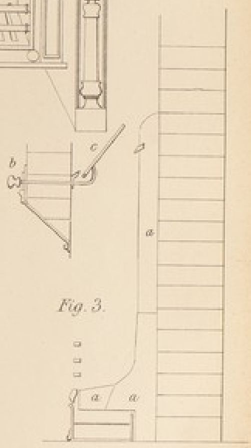


Fig. 4.

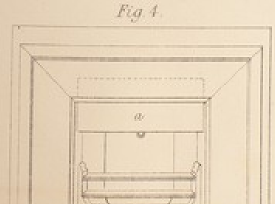


Fig. 5. A grate composed of metal, with a large open space above, such as is now used in a labourer's cottage or in an attic fire-place.

Fig. 6. The same fire-place as fig. 5 contracted. *a, a, a,* fire-brick; *b, b, b,* pieces of slate or stone to reduce the opening.

Fig. 7. Plan of a fire-place situated against an external wall. *a, a, a,* increased thickness of brickwork shown beyond the dotted lines. The thickness of brickwork can also be increased by reducing the size of the chimney.

Fig. 8. Stephen's patent grate. *a,* door to chimney.

Fig. 9. Transverse section of fig. 8.

Fig. 5.

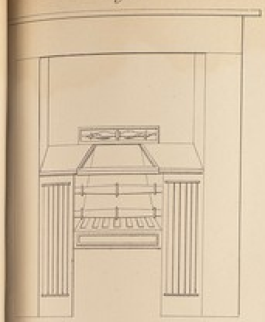


Fig. 6.

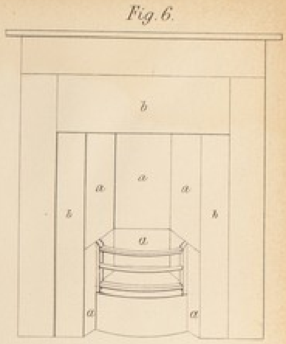


Fig. 7.

Fig. 8.

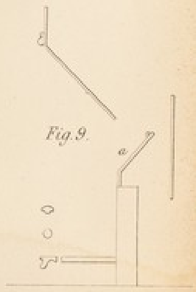


Fig. 9.

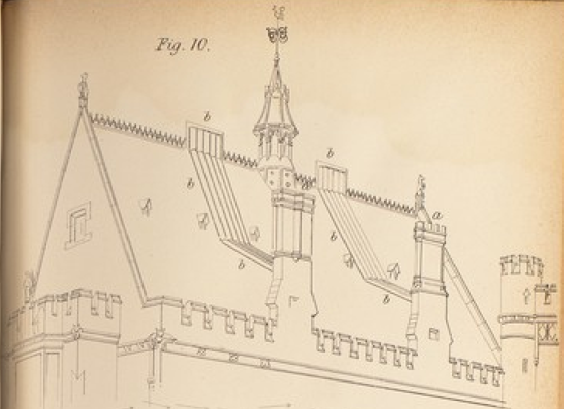
Fig. 10. Roof and upper portion of the Middle Temple Library, from a sketch in *The Builder* of December 15th, 1860; *a*, *a*, tops of chimneys; *b*, *b*, *b*, *b*, metal flues for the passage of the smoke.

Fig. 11. Transverse section of the roof, showing the chimneys closed at top and on the side nearest to the roof, and a shield, *c*, to protect the passage of smoke.

Fig. 12. Section of a simple form of protection against a descending force of wind.

Fig. 13. A similar protecting roof to several chimneys.

Fig. 10.



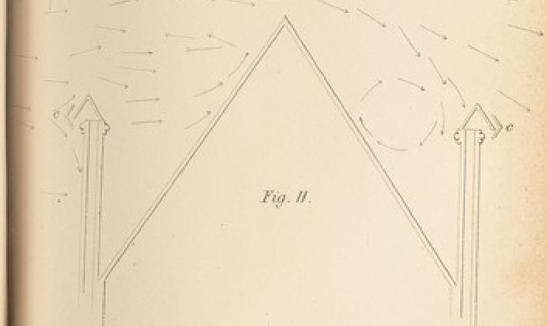


Fig. 11.

Fig. 12.

Fig. 13.

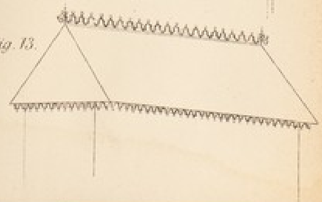


Fig. 14. Roof and upper portion of a mansion in Whitehall, erected from the designs of Mr. William Burn, showing the elevated stacks of chimneys. This sketch is taken from the *Illustrated London News* of September 24th, 1864. A portion only of the details are given here.

Fig. 15. A funnel-tube to reduce the opening into a short chimney, above the fire-place.

Fig. 15.* An iron frame to fix in a chimney above the grate, to which the funnel-tube can be attached by turnbuckles at *a*, *a*.

Fig. 16. An old-fashioned kitchen range with a blower, *c*; two side plates, *a*, *a*; and a front plate, *b*, to contract the opening leading to the chimney.

Fig. 17. Transverse section of a portion of Fig. 15, showing the inclined plate, *b*, and the openings to chimney, *e*, *d*.

Fig. 14.

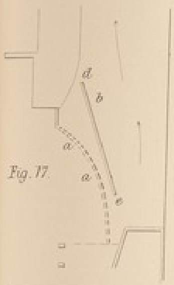


Fig. 17.

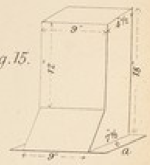


Fig. 15.

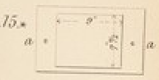


Fig. 15.*

Fig. 16.

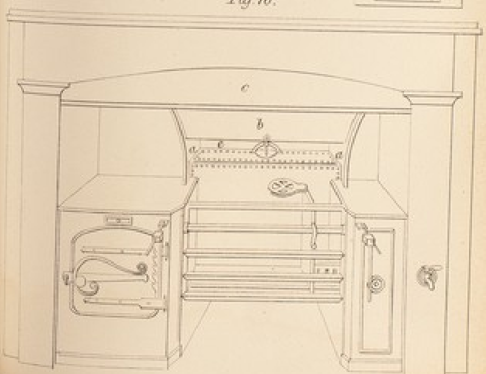


Fig. 18. Sketch of the upper portion of the National Provident Institution, Gracechurch Street, erected from the designs of Professor Robert Kerr, showing the elevated stacks of chimneys. The sketch is taken from *The Builder* of January 3, 1863. A portion only of the details are given here.

Fig. 19. Division for the tops of chimneys in lieu of a chimney pot, suggested by the late Mr. Billing.

Fig. 20. Mr. Billing's reducing piece for the top of a chimney.

Fig. 21. The top of a stack of chimneys, exhibiting the figs. 19 and 20.

Fig. 22. A protecting roof to a stack of chimneys.

Fig. 18.

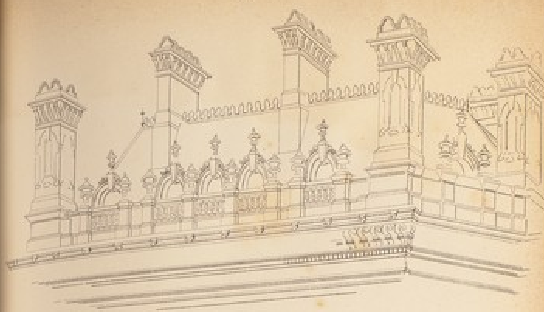


Fig. 19.

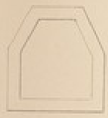


Fig. 20.

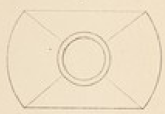


Fig. 21.

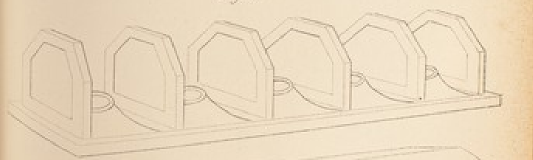
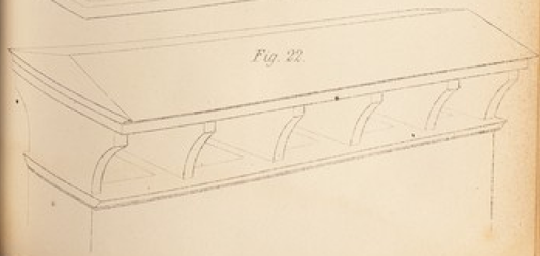


Fig. 22.



Dr E A Parkes. Netley Hospital,
Southampton

with the author's kind regards.

BENGAL BRANCH

OF THE

BRITISH MEDICAL ASSOCIATION.

ABSTRACT OF AN ACCOUNT OF SOME CASES

OF

TYPHUS FEVER

IN THE MEDICAL COLLEGE HOSPITAL, CALCUTTA, UNDER THE CARE OF, AND COMMUNICATED BY,

DR. S. GOODEVE CHUCKERBUTTY.

11th October 1864.

As *Typhus Fever* has been hitherto supposed to be unknown in Bengal, the following cases are submitted, in the hope that their details may prove of interest to professional enquirers on the subject.

CASE I.

Joseph Harlgrave, æt. 25, a Portuguese seaman, of good constitution, living at the *Irish Flag*, was admitted on the 5th July 1864, with a fever of 11 days' standing, and discharged cured on the 23rd August. He presented a maculated mulberry eruption on his trunk, and a dusky red hue of the face and neck and hands, both of which disappeared on pressure, and returned on the pressure being removed. When these faded, they were succeeded by desquamation of the cuticle, and a crop of sudamina on the abdomen. His bowels were relaxed for a day or two in the beginning, and then constipated. He had a frequent and weak pulse, difficulty of respiration, heat of skin, watchfulness, delirium succeeded by stupor and coma, along with involuntary evacuations, a furred dry brown tongue, muscular tremors, subsultus tendinum, and scanty urine, (which became deep-brown and copious as he recovered) and great prostration of strength, headache and pain in the back, redness of the conjunctivæ, &c.

CASE II.

Henry Stampford, æt. 30, an English sailor, living on board the ship *Hippolyta*, admitted on 7th July 1864, with a fever of 2 days' standing, and discharged cured on the 5th August. He presented the same eruption as in the last case, but his other symptoms were lighter. During convalescence he had dysentery.

CASE III.

Hajun, æt. 25, a Mahomedan manjee, living at Nimtollah Ghaut, admitted on the 9th July 1864, with a fever of 10 days' standing, and discharged cured on the 26th July. With the exception of the eruption, he presented all the other severer symptoms as in the first case, but no diarrhœa.

CASE IV.

John Baptist, æt. 44, an East Indian Stevedore, of slender make, living at Tiretta Bazar, admitted on the 16th July 1864 with a fever of 9 days' standing, and discharged convalescent on the 24th July. He presented the mulberry eruption and all other symptoms as in the first case, but no diarrhœa.

CASE V.

Isabella Baptist, æt. 32, wife of the last patient, also East Indian, living at Tiretta Bazar, admitted on the 16th July 1864 with a fever of 12 days' standing, and died on the 20th July. She presented all the symptoms including the eruption as in the first case, but grew rapidly worse and sank. A *post mortem* examination was not allowed.

CASE VI.

James Brown, æt. 25, a well made English sailor, living at the *Irish Flag*, Lall Bazar, admitted on the 30th July 1864 with a dysentery of 14 days' standing, and discharged cured on the 1st September. This man's dysentery rapidly improved, but gradually he got more and more feverish until the 6th August, when he presented the characteristic eruption of a mulberry colour, and the other symptoms as noted in the first case. His bowels were now so constipated that they would not be moved without castor oil.

CASE VII.

J. W. Macmahon, æt. 30, a fair country-born European, unemployed, living at Tiretta Bazar, admitted on the 2nd August with a fever of 6 days' standing, and died on the 9th August. He presented a well-marked maculated mulberry eruption and flushing of the face, and all the other symptoms as in the first case, dying with coma, contorsion of the face, and great jactitation of the body. At the *post mortem* examination the internal organs were found to be hyperæmic, and there was a piece of bone in the falx cerebri, and the cerebral membranes were full of serum, but the peyers patches in the intestines quite healthy.

CASE VIII.

Castello, æt. 30, an unemployed East Indian Clerk, living at Chandney Choke, admitted on the 20th August with a fever of 4 days' standing, and died on the 25th August. He presented the eruption and the other symptoms as in the first case, except that his delirium at first was acute and boisterous. Morbid appearances:—hyperæmia of the internal organs, besides fatty degeneration of the heart and kidneys. The heart contained black fluid blood.

CASE IX.

Oolof Nelson, æt. 21, a Swedish sailor, living in China Bazar, admitted on the 21st August 1864 with a fever of 3 days' standing, and died on the 26th August. He presented the eruption and all other symptoms as in the first case, and died like case 7th. Morbid appearances: congestion of the internal organs, and some softening.

CASE X.

Thomas Fleming, æt. 24, a country-born European, Writer, unemployed, and living at the Alms' House, admitted on the 21st August with a fever of 4 days' standing and a beautiful measley eruption on the trunk, and discharged cured on the 13th October. He presented all the symptoms as in the first case, and had, besides, bed-sores on the back and hips during convalescence.

CASE XI.

Ellen Freeman, æt. 36, a married Irishwoman, mother of several children, living at Vandenburgh's Lane, Tiretta Bazar, admitted on the 17th September 1864 with a fever of 9 days' standing, and died on the 28th September. She presented the same symptoms as in the first case, but her eyes were not congested till towards the end, when she had also petechiæ and vibisces. Morbid appearances:—congestion of the internal organs, and a great accumulation of fat.

Case XII.

John Sullivan, æt. 23, an Irish seaman, living at *Mariners' Hotel*, Lall Bazar, admitted on the 8th October 1864 with a fever of 5 days' standing. He presented the maculated eruption and redness of the face and neck, and the other symptoms as in the first case, except that his delirium was acute at first. He is still in Hospital, getting lower and lower every day (October 28th. Is now quite well, though still very weak.

The preceding narrative forces upon us the melancholy conviction that a continued fever of a fatal type has entered the precincts of Calcutta. During the last three months I have had no less than a dozen cases of it in my wards of the Medical College Hospital alone. Out of these 12 cases, 5 died, a rate of mortality high enough for any country, and especially so for Calcutta, where, in my own experience of the last 15 years, I have never known anything of the kind before. This fact suggests two questions:—*1st*,—Is this the so-called Epidemic Fever which for the last two years has been ravaging the villages of Lower Bengal? and *2nd*,—Can it be the *Typhus Fever* of Europe?

To the first question I do not feel that I am in a position to return a satisfactory answer. I do not even know what the *Epidemic Fever* is, having never had an opportunity of visiting the places said to be smitten with it. Persons have sometimes come under my treatment in the Hospital, who, I was told, had had the Epidemic Fever, but who had passed safely through the acute stage, and were only suffering from chronic intermittent fever and enlargement of the spleen and liver, alone or together, at the time of their admission. These, no doubt, were the sequelæ, and not the essential features of the Epidemic. Occasionally in private practice I have had cases of severe intermittents, contracted in the epidemic districts, who had immediately, on getting the disease, removed to Calcutta and placed themselves under

my treatment. To say that I have seen the Epidemic Fever upon such data would be clearly incorrect. Nor can I make out its exact pathology and symptoms from the Reports submitted to Government by Dr. Elliott and the Epidemic Commission. They seem to have laboured with commendable zeal and to have drawn up able papers; but whether owing to want of sufficient materials to go upon, or to want of leisure, they seem to have failed in giving detailed descriptions of the symptoms from day to day, and of the *post mortem* appearances in cases of death. Had I had those facts before me I should have been able to compare them with mine. In the absence of that information I am unable to accept statements as to the nature of the Epidemic Fever, statements which, however strong, do not seem to be sufficiently clear to my mind, nor calculated to carry conviction with the general public. To assert that it is due to exuberant vegetation, when exuberant vegetation is not a new thing in the History of Bengal, is an argument entirely arbitrary; and to make that assertion, too, without a minute and detailed statement of the symptoms and *post mortem* appearances in a single authenticated instance is to tax too highly our professional credulity.

Apart, however, from all pretension of personal knowledge of the subject, and without professing to understand it from the published Reports, I may roughly observe that during the last 3 months I have certainly noticed a much higher rate of mortality from fever in Calcutta than I had ever known to occur during the previous fourteen years. Deaths from Remittent Fever have been unusually frequent, and even the Intermittent cases have terminated fatally oftener than before. From Typhus Fever, a disease the very existence of which in this country has been doubted or denied, there have been no less than five deaths under my care alone. Then there have been cases of the Red-Fever and Sun-Fever, but none of these have died so far as I could learn. I am not aware if there have been any persons dying of the Typhoid Fever this year in this country; but I have heard of some deaths from *Typhus*, though only in a loose way, in the practice of others.

In replying to the second question—"Can it be the Typhus Fever of Europe," to smooth the way, I would refer to the descriptions of the *Typhus* by Cullen, Watson, Graves, Copland, and Murchison. Of these the last gentleman, the most recent writer on this subject, defines Typhus as follows:—

"A disease attacking persons of all ages, generated by contagion, or by overcrowding of human beings, with deficient ventilation, and prevailing in an epidemic form in periods, or under circumstances, of famine and destitution. Its symptoms are, more or less, sudden invasion marked by rigors or chilliness; frequent compressible pulse; tongue furred, and ultimately dry and brown; bowels, in most cases, constipated; skin warm and dry; a rubeoloid rash appearing between the fourth and seventh days, the spots never appearing in successive crops, at first slightly elevated, and disappearing on pressure, but after the second day persistent, and often becoming converted into true petechiæ; great and early prostration; heavy flushed countenance; injected conjunctivæ; watchfulness and obtuseness of the mental faculties, followed, at the end of the first week, by delirium, which is sometimes acute and noisy, but oftener low and wandering; tendency to stupor and coma, tremors, subsultus, and involuntary evacuations, with contracted pupils. Duration of the fever from ten to twenty-one days, usually fourteen. In the dead no specific lesion; but hyperæmia of all the internal organs, softening of the heart, hypostatic congestion of the lungs, atrophy of the brain, and œdema of the piamater are common."

Further on, in speaking of the geographical distribution of this fever, Dr. Murchison makes the following statement at p. 58 of his *Treatise on Continued Fevers*:—

"As yet there are no authentic records of Typhus, such as we see it in this country, having been met with in Asia, Africa, or the tropical parts of America. * * *. Dr. Ewart has described two cases of 'Typhus' as occurring in the Jail of Ajmere, in Bengal; but the characteristic eruption was absent, and there was no evidence of contagion. Dr. Allan Webb, in his 'Pathologia Indica,' had previously mentioned two cases of fever observed at Simlah, where petechiæ were present. But the fever is not said to have been contagious, and petechiæ are occasionally observed in the severe remittents of India, which have often been mistaken for Typhus. According to Dr. Morehead, Typhus is unknown on the Continent of India.

"In 1861, Dr. W. Walker, of H. M.'s Indian Army, described an epidemic of 'Typhus' prevalent in the preceding year in the North-Western Provinces of India, and observed by him in the Central Prison of Agra. But the evidence that the disease was genuine Typhus, as seen in this country, is to my mind not conclusive. An eruption was never detected upon the skin, although it was carefully looked for; the swarthy skin of an East Indian would not suffice to obscure the eruption of Typhus in its petechial stage; for I have known the eruption distinctly developed in Africans and East Indians."

I have been thus careful in making the foregoing extracts on Typhus, in order to bring prominently forward the most essential characters of the disease, so that we might so much the more easily compare them with the details of my own cases, and also, at the same time, subject these latter to the severest test in presence of the adverse opinions of two of the greatest authorities of the day as regards the occurrence of Typhus Fever in India. Both Drs. Murchison and Morehead are explicit on this point; and both, from their acknowledged ability and learning, deserve to be treated with the highest respect. But, however high their authority in the world of science, the authority of facts must be allowed to possess a still higher claim; and it is to facts alone that I wish to appeal in confirmation of my position that the cases related by me were genuine cases of *Typhus Fever*. I have been looking out now for more than fourteen years for cases of this fever, but never before did I meet with one instance in which I could identify it. The case of Joseph Harlgrave, therefore, came upon me as a real surprise, and excited so much interest that I took every opportunity of showing him to my colleagues and other medical friends. Since his admission on the 5th of July up to this day (11th October 1864), my wards have never been free from 'Typhus Fever,' although the total number received under me has been as yet only 12. Of the other varieties of fever admitted into my wards during the same period, there were intermittents 119, died 6; remittents 26, died 5; Red-fever 1, cured; Sun-fever 2, cured; doubtful or suspicious cases, recovered fast, 3; heat-apoplexy 3, all died.

Of the 12 cases of Typhus, 5 have died, 5 have been discharged cured, 1 is thoroughly convalescent (since discharged), and 1 admitted only four days ago. Thus, while the mortality from intermittent fever was 5 per cent., and from remittent fever 19·23 per cent., from the Typhus Fever it has been as high as $41\frac{2}{3}$ per cent.

Of the 12 cases of Typhus Fever, 10 were in men and 2 in women. With regard to their nationalities and occupations, 1 was a Portuguese sailor (the first case admitted); 1 a Swedish sailor; 3 East Indians (one man a Stevedore); 2 country-born Europeans; 1 a Mahomedan boatman; 2 English sailors; 2 Irish, the man a sailor. One East Indian and the two country-born men were unemployed at the time; and one of the women, the wife of the Stevedore.

As to the localities from which they came, 2 were from the *Irish Flag*, Lall Bazar; 1 from *Mariners' Hotel*, Lall Bazar; 4 from *Tiretta Bazar*, near Lall Bazar; 1 from *China Bazar*, near Lall Bazar; 1 from *Chandney Choke*, within 200 yards of Lall Bazar; 1 from the *Alms' House*, Amherst Street; 1 from a boat at the Nimtollah Ghaut (close to the Burning-place); 1 from the ship *Hyppolyta*.

With regard to their age, three were 25 years old; two 30; one 44; one 32; one 37; one 21; one 24; one 36; one 23.

Of these, one was admitted with a fever of two days, one of three days, three of four days, one of six days, two of nine days, one of ten days, one of eleven days, one of twelve days, one of fourteen days. In the last case the disease was masked by dysentery till some days after his admission.

Of the cases cured the whole time from invasion to discharge was in two 30 days, one 27 days, one 18 days, one 17 days. Of the two cases in Hospital, in one it has been 56 days and in one 9 days. Of the cases that died from invasion to death, in one 9 days, in one 13 days, in one 16 days, in one 17 days, in one 20 days.

The entire duration of their stay in the Hospital, when discharged cured, was in one 32 days, in one 9 days, in one 18 days, in one 29 days, in one 50 days; when died, in two 4 days, in one 17 days, in one 5 days, in one 10 days. Of the two cases still in Hospital, one man has been 52 days (discharged two days afterwards), and the other as yet only four days.

In 11 of these the peculiar rash was noticed to be present. It was of a mulberry colour; macular in form; varying in size; sometimes appearing elevated to the eye, like the eruption of measles, sometimes no higher than the skin; always disappearing on pressure, and returning on its removal; observed between the third and seventh days, sometimes later; and fading away and vanishing after some five or six days, sometimes sooner, sometimes later. The only case in which it could not be made out was that of the Mahomedan boatman, though he had had all the other symptoms of Typhus.

The pulse was frequent and weak in all.

The respiration hurried, and more or less difficult in all.

Headache and pain in the back in most.

The conjunctivæ were congested in all, sooner or later.

The pupils sometimes contracted, sometimes of moderate size and sluggish, never dilated.

The skin was hotter than natural, with, in some cases, the cuticle desquamating during convalescence.

The tongue was loaded, dry and black, or glazed and leathery.

The teeth and lips were covered with black sordes.

The countenance was in all heavy and flushed.

The mind was in a state of delirium, stupor, or coma.

Muscular tremors were present in all, and subsultus tendinum in most.

Dulness of hearing, and want of sleep and appetite existed in almost all.

The bowels were mostly constipated, sometimes loose; in the worst cases moved involuntarily.

The urine was scanty and high coloured, passed involuntarily in the worst cases, not albuminous.

There was no pain in the abdomen, except sometimes in the hypochondria; only in one or two cases there was gurgling in the iliac regions for one or two days; tympanitis in most.

Prostration of strength was always considerable, and, when recovery took place, the patients were long in regaining their strength.

Of the morbid appearances, congestions of the lungs, kidneys, and brain have been the most frequent, occasionally also of portions of the intestines and stomach, and sometimes of the liver and spleen to a small extent; flabbiness of the heart, and blackness and fluidity of the blood, without coagula, in all cases; prominence of Brunner's glands in one, affection of Peyer's patches in none; in one case an osseous piece attached to the falx cerebri; cerebral membranes always congested and contained much serum.

It remains now to consider the question of contagion. Is the fever of which 12 cases have been given above contagious? This is a point more easy to moot than to answer. Although now-a-days the contagiousness of Typhus Fever is almost universally admitted, yet it required long years ere the profession was unanimous about it. The fact is, that it is one thing to be morally convinced that a disease is contagious, and another thing to be able to bring home that conviction to others by unquestionable proofs. Even to this day the contagiousness of Cholera is a debateable ground. Those who believe it to be contagious appeal apparently to overwhelming evidence, when they bring forward cases of its occurrence in persons who had had intercourse with Cholera patients, and who had, in their opinions, carried it with them from one place to another. Those again, who, like myself, have seen the disease on a large scale without its infecting the attendants more than could be accounted for by the atmospheric condition, reject the contagiousness of Cholera *in toto*. I mention this fact not to call in question the contagiousness of Typhus, but simply to show how difficult it is to prove it. That Typhus *is* contagious is granted. But that my cases were those of Typhus is held to be doubtful till they are proved to be contagious. To solve this difficulty I fear I cannot offer much in the shape of direct demonstration, and it is on that account that I wish to impress on my professional brethren the nature of the task. But because I cannot advance direct proofs, it does not follow that the disease is not contagious. In favour of it, we have—1stly, the interesting fact that the persons affected had mostly led a sea-faring life; 2ndly, that the majority of them came from Lall Bazar and its immediate vicinity, there being only one from the shipping, one from the Alms' House, and one from the Nimtollah Ghaut; 3rdly, that at no one time were there more than three cases distributed through four wards of the Hospital; 4thly, that the ventilation of the Hospital is the most complete; 5thly, that the beddings were immediately and invariably either destroyed or sent to the washerman on the discharge or death of every case, and the bedsteads, after being washed with boiling water, were left exposed to the sun for some days before being returned to the wards. We are bound, therefore, to take into account the short duration of the disease among us as yet, the small number of cases, the thoroughness of the ventilation, and the adoption of precautionary measures against the spread of contagion, in disposing of this question; and then say, after allowing for the efficacy of

these things in checking contagion, whether the disease under notice is contagious or not. For my own part I believe that it *is* contagious, for in one man (James Brown), who was admitted for dysentery, it did appear as if the fever had been caught from Harlgrave, who was in the same Boarding-house, either outside or in the Hospital; in a second case, both the husband and wife were admitted with it on the same day, the wife having been ill 12 days and the husband 9 days, consequently the latter having caught the fever most probably from the former. Besides, there were also several slighter cases, which certainly did occur in the Hospital, but, as in them the rash did not last long and the fever soon got well, I have placed them among the suspected cases.

Now, I think, if due allowance be made for all these things, the conclusion is inevitable that the fever I have alluded to *is* contagious, and, further, that it is *Typhus*,—an opinion fully supported by its heavy rate of mortality ($41\frac{3}{4}$ per cent.), which is as high as during the worst years in London, as noticed by Dr. Murchison (1858, 60 per cent.; 1859, 37·5 per cent.; 1860, 40 per cent.)

How did Harlgrave catch this fever? Did he bring it from the Portuguese ship? I made every inquiry on this point, but could elicit nothing. Did he get it on shore? The only circumstances in favour of it are, that an Epidemic Fever is known to be raging in Bengal; that all the fevers this year have been peculiarly fatal, and that the overcrowded state of the sailors' Boarding Houses, situated, as they are, in the dirtiest part of the town, in Lall Bazar, is extremely likely to have given rise to it.

Darstellung

der

Lehre von den Trichinen,

mit Rücksicht auf

die dadurch gebotenen Vorsichtsmaßregeln,

für Laien und Aerzte,

von

Rud. Virchow, Dr. med. et phil.

Professor der pathologischen Anatomie, der allgemeinen Pathologie und Therapie,
Director des pathologischen Instituts, dirigirendem Arzt an dem Charité-Krankenhause,
Mitglied der Wissenschaftlichen Deputation für das Medicinalwesen im Ministerium
der geistlichen-, Unterrichts- und Medicinalangelegenheiten.

Mit fünf Holzschnitten und einer Tafel.

Berlin.
Druck und Verlag von Georg Reimer.
1864.

Die immer häufiger werdenden Beobachtungen über Erkrankungen und selbst Todesfälle bei Menschen, welche durch einen mikroskopischen Wurm, die Trichine, erzeugt werden, haben allmählich die Aufmerksamkeit des größeren Publikums erregt und an vielen Orten den gebührenden Schrecken über eine so große, in der Nahrung gegebene Gefahr hervorgerufen. Zahlreiche Anfragen von Aerzten und Laien, denen einzeln zu genügen einen unverhältnißmäßigen Zeitaufwand erfordert, bestimmen mich, zur Aufklärung des Sachverhältnisses die wichtigsten Thatsachen kurz zusammenzustellen und durch naturgetreue Abbildungen das Verständniß derselben auch einem größeren Leserkreise, dem die gelehrten Hülfsmittel gar nicht oder wenigstens nicht vollständig zugänglich sind, zu erschließen. Ich bemerke dabei ausdrücklich, daß ich nur Thatsachen berichten und, wo diese noch nicht ganz ausreichen, die Lücken unseres Wissens offen bezeichnen werde. Wenn die Thatsachen aber zuweilen über das vielen Laien als anständig erscheinende hinausgehen, so bitte ich das mit der Natur des Gegenstandes zu entschuldigen. Naturalia non sunt turpia.

Die Trichine, wie sie im Fleisch vorkommt, ist, wie schon gesagt, ein mikroskopisches Thierchen, oder mit anderen Worten, sie ist für das unbewaffnete Auge unter den gewöhnlichen Verhältnissen unsichtbar.

Man muß deshalb nicht meinen, wie ich hier und dort gehört habe, daß sie den kleinsten Infusorien gleichzustellen sei, von denen manche Laien fälschlich glauben, daß sie überall, in jedem Wassertropfen und in jedem Lufttheilchen, in großen Mengen vorkommen. Reines Wasser, reine Luft, reines Fleisch enthält weder Infusorien, noch sonst irgend eine andere Art von Thieren. Nur unreine, faulige oder verdorbene Flüssigkeiten oder organische Theile können Infusorien enthalten, doch ist dies keineswegs jedesmal der Fall. Mit solchen, mehr oder weniger allgemein verbreiteten Thierchen hat die Trichine nichts gemein. Sie gehört in eine ganz andere Klasse von Thieren, in die der eigentlichen Würmer, und sie findet sich nur unter ganz besonderen Bedingungen. Auch ist sie nicht so klein, daß sie deßwegen allein für das bloße Auge nicht wahrnehmbar wäre; im Gegentheil können wir andere Körper von gleicher Kleinheit noch sehr bequem sehen. Nicht selten erreicht sie eine Länge von $^1/_3$—$^1/_4$ Linie.

Allein ihr Körper ist im hohen Grade durchsichtig, was sich daraus erklärt, daß die einzelnen Theile und Organe desselben sehr wenig entwickelt sind. Wäre der Körper undurchsichtig, würfe er das auffallende Licht zurück, so würde man bei aufmerksamer Betrachtung und gutem Auge das Thier jedenfalls leicht sehen. Dieß läßt sich aber nur ermöglichen, wenn man die günstigsten Umstände der Betrachtung vereinigt. Bringt man eine Trichine, deren Körper zusammengerollt, also auf einen kleineren Raum zusammengedrängt ist und dadurch auf diesem Raum eine größere Menge fester Substanz sammelt, in einem Tröpfchen Wasser auf eine Glasplatte und legt diese auf eine schwarze Unterlage, so

erblickt man ein weißliches Pünktchen. Mehr ist freilich nicht zu sehen, und auch so ist es ganz unmöglich, zu erkennen, daß dieß Pünktchen ein Thier ist.

Sehr häufig ist das Thier in dem Fleisch eingeschlossen in eine besondere Kapsel, in eine Art von Säckchen ohne Oeffnung, in eine sogenannte Cyste. Diese Kapsel hat zuweilen eine sehr beträchtliche Größe und Dicke. Ist sie noch unvollständig und zart, so ist auch sie für das bloße Auge kaum erkennbar; wird sie aber mehr und mehr ausgebildet, nimmt sie an Dicke und Dichtigkeit zu, und lagern sich endlich in sie Kalksalze ab, so setzt sie dem Durchgange des Lichtes immer mehr Hindernisse entgegen, sie wird undurchsichtig und erscheint endlich dem bloßen Auge als ein kleines, weißliches Körperchen.

Diese Körperchen waren es, welche vor 30 Jahren die Aufmerksamkeit der Aerzte erregten. Ein englischer Anatom, Hilton scheint der erste gewesen zu sein, der sie genauer untersuchte. Er hielt sie für thierische Gebilde, aber er erkannte noch nicht den in ihnen enthaltenen Wurm. Erst 1835 wurde dieser von dem berühmten Zoologen Owen beschrieben und von ihm mit dem Namen der Trichina spiralis belegt, weil der Körper so fein, wie Haare (triches), und zugleich spiralförmig aufgerollt zu sein pflegt. Eine Reihe von Beobachtern in England, Deutschland, Dänemark, Frankreich und Nordamerika stellten nach und nach das Vorkommen eingekapselter Trichinen bei Menschen dieser verschiedenen Länder fest. Bei Thieren stehen die Fälle noch sehr vereinzelt. Man fand sie bei der Katze [1]), bei Krähen, Dohlen, Habichten und andern Vögeln, sowie bei Maulwürfen [2]) und Schwei-

[1]) E. F. Gurlt, Nachträge zu dem ersten Theile seines Lehrbuches der pathologischen Anatomie der Hausthiere. Berlin. 1849. S. 144.

[2]) Jul. Vogel, Pathologische Anatomie des menschlichen Körpers. Leipzig 1845. S. 422. Herbst, über die Natur und die Verbreitungsweise der Trichina spiralis. Nachrichten von der G. A. Universität und der Königl. Gesellschaft der Wissenschaften zu Göttingen. 1852. Nr. 12. S. 183.

nen [1]); jedoch ist es noch jetzt nicht ausgemacht, ob alle diese Befunde derselben Art angehören oder ob nicht vielmehr eine andere Species, die Trichina affinis [2]), mit untergelaufen ist.

Obwohl nun unter den Gelehrten darüber Streit bestand, ob die Kapsel, in welcher sich das Thierchen befindet, ganz oder nur theilweise oder gar nicht zu dem Thier, als ein Theil desselben gehört, so gewöhnte man sich doch allmählich daran, Kapsel und Thier als Eines zu betrachten und nur solches Fleisch als trichinisches anzusehen, in welchem man mit bloßem Auge die weißen Körperchen erkennen konnte.

Diese Auffassung konnte nur unter einer Voraussetzung richtig sein. Wenn die Kapsel eine Eischale war, wenn also die Thiere sich an dem Orte, wo sie gefunden wurden, aus Eiern entwickelten, so mußte allerdings unter allen Umständen die Kapsel von Anfang an vorhanden sein. Dieß war jedoch in hohem Maaße unwahrscheinlich, und es hat sich auch bei späterer genauerer Untersuchung ergeben, daß von Eiern hier nicht die Rede sein kann. Damit gewinnt natürlich die Kapsel eine andere Bedeutung. Mochte sie nun eine Absonderung, ein Erzeugniß des Thieres, oder eine Bildung des menschlichen Körpers, in welchem sich das Thier befindet, sein, so mußte doch irgend eine Zeit existiren, wo das Thier nicht eingekapselt, wo es frei war. Allein Niemand hatte beim Menschen solche freien Trichinen gesehen. Die erste Beobachtung dieser Art wurde im Jahr 1860 durch Zencker [3]) in Dresden gemacht, in einem tödtlichen Falle von

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[1]) Jos. Leidy, Ann. and. Magaz. of nat. hist. 1847. pag. 358. Frorieps N. Notizen. 1847. III. S. 219.

[2]) Diesing, Revision der Nematoden. Sitzungsberichte der mathematisch-naturwiss. Classe der k. Akademie der Wissenschaften zu Wien. 1861. Bd. XLII. S. 694.

[3]) Zencker, Ueber die Trichinen-Krankheit des Menschen. Virch. Archiv für pathologische Anatomie und Physiologie und für klinische Medicin. Bd. XVIII. S. 561.

Trichinenkrankheit, der auch sonst von großer Bedeutung geworden ist und auf den ich noch mehrfach zurückkommen werde.

Wir wissen jetzt, daß eine längere Zeit, mindestens von zwei Monaten, nöthig ist, um eine vollständige Kapsel zu erzeugen, und daß ein Mensch oder ein Thier, welche so lange am Leben bleiben, daß die in ihnen vorhandenen Trichinen eingekapselt werden, ziemlich über die Periode der Gefahr hinausgekommen sind. Wir können daher auch sagen, daß alle Beobachtungen über das Vorkommen von Trichinen beim Menschen, welche bis zum Jahre 1860 gemacht worden sind, sich auf geheilte Fälle beziehen.

Man wird es deshalb leicht begreiflich finden, daß sich mehr und mehr die Meinung verbreitete, die Trichine sei ein ganz unschädliches Thier, welches mehr als eine Curiosität zu betrachten sei. Die practischen Aerzte verloren das Interesse daran und überließen es den Anatomen und Zoologen, den Gegenstand als einen rein wissenschaftlichen weiter zu verfolgen.

In der That hatte derselbe ein sehr hohes wissenschaftliches Interesse, und diesem Umstande hauptsächlich ist es zu danken, daß sich auch hier das alte Wort von dem Steine, den die Bauleute verwarfen und der dann zum Eckstein ward, bestätigt hat. Das Wunderbare an der Trichine war nämlich, daß man nicht bloß in völliger Ungewißheit darüber sich befand, woher sie komme und wie sie in das Fleisch lebendiger Menschen hineingelange, sondern auch an ihr nichts zu entdecken vermochte, was auf eine Fortpflanzung hindeutete. Denn man fand weder Junge, noch Eier, noch überhaupt entwickelte Geschlechtsorgane.

Bis vor nicht sehr langer Zeit hatte man sich in solchen Fällen freilich zu helfen gewußt, indem man eine sogenannte Urzeugung (Epigenese, Generatio aequivoca s. spontanea) annahm. Seit alten Zeiten hatte sich nicht bloß im Volk, sondern auch bei einer gewissen Zahl von Forschern die Meinung erhalten, daß aus gewissen Stoffen, besonders aus allerlei Unrath oder fauligem Wesen, lebendige Thiere, namentlich Ungeziefer, entstehen könnten. Dahin rechnete man namentlich auch die meisten der Eingeweidewürmer, bei denen man am allerwenigsten begriff, wie sie mitten in anderen Thieren vorkommen könnten, wenn sie nicht in ihnen selbst gleichsam durch eine neue Schöpfung entstanden wären. Bei den Trichinen lag ein solcher Gedanke um so mehr nahe, als sie dem Anschein nach ganz geschlechtslos waren und aller der Eigenschaften entbehrten, an welche sonst das Fortpflanzungsgeschäft geknüpft ist. Dazu kam, daß sie sich in ganz ungeheuren Mengen finden, indem in manchen Fällen Millionen von Trichinen in einem Menschen gleichzeitig vorhanden sind. Eine so große Zahl ist von keinem anderen menschlichen Eingeweidewurm jemals beobachtet worden. Sollte man also nicht gerade bei den Trichinen am ersten vermuthen, daß sie aus irgend welchen Unreinigkeiten im Körper ihren Ursprung nähmen?

Am meisten gleichen die Trichinen in dieser Beziehung gewissen Blasenwürmern, insbesondere den Finnen, welche bekanntermaßen bei Schweinen nicht selten sind, aber auch beim Menschen oft genug gefunden werden. Die Finnen oder Cysticerken unterscheiden sich dadurch von den Trichinen, daß sie ungleich größer sind. Während die Trichinen, auch wenn man die Kapseln zu dem Thiere rechnet, höchstens einen kleinen weißen Punkt oder eine feine Linie darstellen, so pflegen die Cysticerken die Größe einer Erbse, zuweilen die einer kleinen Kirsche oder Bohne zu erreichen. Eine Verwechselung beider ist daher selbst für den Ungeübten nicht möglich. Aber auch die Finnen sind geschlechtslos, sie haben nie Eier, sie kommen häufig in großer Zahl vor, sie sitzen im Fleisch, sie sind also in vielen Stücken den Trichinen sehr ähnlich, und auch bei ihnen schien die Entstehung durch Urzeugung die wahrscheinlichste.

Schon die besseren Untersucher des vorigen Jahrhunderts, namentlich der verdiente Quedlinburger Pastor Göze, haben bemerkt, daß der Finnenwurm eine große Uebereinstimmung des Baues mit dem Kopfe eines Bandwurmes besitzt, und sie hatten beide, den Finnenwurm und den Bandwurm, deßhalb zu einem und demselben Geschlecht, dem der Tänien, gerechnet. Indeß betrachteten sie doch beide als getrennte Arten (Species) desselben Geschlechts (Genus), welche neben einander beständen, wie etwa Esel und Pferd, Hund und Wolf, ohne jemals in einander über- oder auseinander hervorzugehen. Erst die weiter gehende Forschung der neueren Zeit führte zu dem Gedanken, daß das Verhältniß ein näheres und der Finnenwurm ein wirklicher, unter besonderen Bedingungen abweichend entwickelter Bandwurm sei. Allein die unmittelbare Erfahrung, wie sie zuerst von Küchenmeister auf dem Wege des Versuches gewonnen wurde, lehrte, daß auch diese Vermuthung noch nicht die ganze Wahrheit ausdrückte. Es ergab sich vielmehr, daß der Finnenwurm des Fleisches, wenn er von einem Thiere oder Menschen gegessen wird, sich im Darm desselben in einen Bandwurm verwandelt oder vielmehr zu einem Bandwurm entwickelt, daß also derselbe Wurm eine Zeit lang in dem Finnenzustand lebt, um später in den Bandwurmzustand überzugehen.

Schwieriger war die Frage, wie der Wurm in den Finnenzustand und in das Fleisch gelangt. In dem Bandwurmzustand erzeugt er an seinem hinteren Leibesende durch Wachsthum und Abschnürung immer neue Glieder, von denen jedes in sich nicht bloß Eier, sondern auch lebendige Junge hervorbringt. Diese schlüpfen aber aus der Eischale erst aus, nachdem sie mit den Stuhlgängen aus dem Körper entleert worden und auf irgend eine Weise, sei es mit der Nahrung, sei es mit dem Getränk, sei es sonstwie zufällig, wieder von einem Thiere oder Menschen genossen sind. Sobald sie in den Magen gelangt sind, so löst sich die Schale, die jungen, dann noch mikroskopischen Thierchen werden frei, durchdringen die Darmwand und gelangen durch active und passive Wanderung in verschiedene Theile des Körpers, um sich zu Finnenwürmern zu entwickeln.

Es ist dies eine lange und in hohem Maaße dem Zufalle überlassene Entwicklungsreihe. Der Finnenwurm muß, in der Regel mit dem Fleische, worin er enthalten ist, gegessen werden, um zum Bandwurm zu werden, und die von diesem in seinen einzelnen Gliedern erzeugten Eier und Jungen müssen wiederum genossen oder wenigstens eingenommen werden, um in das Innere des Körpers und namentlich in das Fleisch eindringen und sich hier zu neuen Finnenwürmern ausbilden zu können. Es findet hier also nicht bloß ein mehrfacher Ortswechsel, sondern auch ein Generationswechsel statt; denn ein jedes Bandwurmglied ist wenigstens ein Repräsentant einer besonderen Generation.

Mit diesen Erfahrungen war die alte Lehre von der Urzeugung der Eingeweidewürmer auf das Tiefste erschüttert. Wenn selbst so große Thiere, wie die Finnenwürmer, regelmäßig von Generation zu Generation und zwar aus Eiern erzeugt werden, um durch besondere Wanderungen vom Darm in das Fleisch (die Muskeln) zu gelangen, so lag es überaus nahe, zu vermuthen, daß mit den Trichinen etwas Aehnliches vorgehe. Eine wirkliche Entscheidung darüber ließ sich natürlich nur auf dem Wege des Versuches gewinnen.

Diesen Weg betrat zuerst Herbst in Göttingen, und er fand in der That, daß Thiere, die mit trichinischem Fleische gefüttert waren, später wieder Trichinen in ihren Muskeln hatten. Seine Versuche hatten aber einen doppelten Mangel. Einmal war nicht festgestellt, daß die von ihm zur Fütterung verwendeten Trichinen mit den beim Menschen vorkommenden identisch seien; andermal war es ihm nicht geglückt, die Geschichte der Vorgänge zwischen der Zeit, wo die zur Fütterung verwendeten Trichinen in

den Magen gelangten, und derjenigen, wo sich wieder Trichinen in den Muskeln fanden, zu ermitteln. Gab es hier auch einen Generationswechsel? verwandelten sich die Trichinen im Darm in einen anderen Eingeweidewurm? erzeugten sie Eier? oder waren es dieselben Trichinen, welche zur Fütterung verwendet wurden, die man nachher in den Muskeln wiederfand?

Weitere Fütterungsversuche, namentlich von Küchenmeister, ergaben kein Resultat, doch stellte der letztgenannte die Vermuthung auf, daß die Trichine im Darm sich in einen andern bekannten Eingeweidewurm, den Trichocephalus, verwandele, daß also die Trichine der Jugendzustand des Trichocephalus sei. Diese Vermuthung schien sich Anfangs zu bestätigen.

Leuckart in Gießen, der schon früher nach der Fütterung von trichinischem Fleische bei Mäusen freie Trichinen im Darmschleim gefunden hatte, ließ am 28. September 1859 der Pariser Akademie die Mittheilung machen, daß es ihm gelungen sei, bei einem Schweine Trichocephalen in großer Menge aus Trichinen zu erziehen.

Ich war inzwischen zu einem anderen Resultate gekommen. Bei einem Hunde, dem ich eingekapselte, aber lebende Trichinen vom Menschen beigebracht hatte, fand ich schon $3\frac{1}{2}$ Tage nach der Fütterung zahlreiche, freie und sehr gewachsene Thiere im Darm, welche zugleich eine volle geschlechtliche Entwickelung gemacht hatten. Ich konnte männliche und weibliche Thiere unterscheiden und in ihrem Leibe fand ich zahlreiche Eier und Samenzellen. Meine ersten Mittheilungen darüber machte ich in der Sitzung der Gesellschaft für wissenschaftliche Medicin zu Berlin am 1. August 1859,[1]) genauere in meinem Archiv.[2]) Ich zeigte zugleich, daß

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[1]) Deutsche Klinik. 1859. S. 430. Compt. rend. de l'Acad. des sciences. T. XLIX. p. 660.

[2]) Archiv für pathol. Anat. und Physiol. Bd. XVIII. S. 342.

die Kapsel, in welcher das Thier eingeschlossen im Fleische gefunden wird, nichts anderes sein könne, als eine veränderte Muskelfaser, ein entartetes Primitivbündel, daß also die Thiere in die eigentlichen Formelemente des Fleisches eindringen müßten.

Beides ist durch spätere Fütterungsversuche, zunächst durch Leuckart und mich selbst, sodann durch Claus und Andere bestätigt worden. Insbesondere der durch Zencker im Januar 1860 beobachtete und schon erwähnte Fall gab sowohl Leuckart als mir neues Material zu Versuchen. Ersterer hat darüber in einer größeren Schrift ausführlich berichtet[1]); ich habe meine Erfahrungen zuerst in einer kürzeren Notiz in meinem Archiv[2]), sodann in einer längeren Mittheilung an die Pariser Akademie[3]) veröffentlicht. Das Hauptergebniß der beiderseitigen, unter vielfacher brieflicher Verständigung angestellten Versuche war das, daß die gefütterte Trichine aus dem Fleisch (Muskeltrichine) sich im Darm in kurzer Zeit zu einem erwachsenen, aber sonst nicht weiter verwandelten Thier (Darmtrichine) ausbildet, welches Eier und lebendige Junge in sich erzeugt, und daß diese lebendigen Jungen, ohne das befallene Thier zu verlassen, sofort die Darmwand durchdringen, in den Körper und speciell in die Muskelfasern einwandern und, wenn das betroffene Thier nicht früher zu Grunde geht, hier endlich eingekapselt werden, um auf den Augenblick zu harren, wo sie wieder von einem anderen Thiere oder Menschen verspiesen werden.

Es verhalten sich demnach die Trichinen in einer Beziehung ganz anders, als die Band- und Finnenwürmer. Sie brauchen nicht zweimal, sondern nur einmal genossen zu werden, um eine

[1]) Leuckart, Unterfuchungen über Trichina spiralis. Leipzig u. Heidelb. 1860.

[2]) Mein Archiv. 1860. Bd. XVIII. S. 535.

[3]) Compt. rend. T. LI. p. 13. vgl. Gaz. méd. de Paris. 1860. No. 28. p. 440.

neue, den Körper durchwandernde Brut hervorzubringen. Die Gefahr ist demnach ungleich größer, ganz abgesehen davon, daß Band- und Finnenwürmer kaum jemals lebensgefährliche Zufälle hervorrufen, während wir gegenwärtig schon eine große Zahl von Fällen kennen, in welchen der Tod durch Trichinen bedingt worden ist.

Andererseits stimmen die Muskeltrichinen und die Finnenwürmer darin überein, daß nicht dieselben Thiere, welche mit dem Fleische genossen werden, vom Darm aus in die Muskeln einwandern, sondern daß sie im Darm junge Brut erzeugen und daß erst diese Brut in die Muskeln gelangt.

Nach dieser allgemeinen Uebersicht von der Entwickelung unseres Wissens über die Trichinen werde ich jetzt die Hauptpunkte etwas genauer durchgehen.

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1) Wie erkennt man die Trichinen im Fleische?

Schon im Eingange habe ich hervorgehoben, daß abgesehen von dem besonderen Fall, wo man unter den günstigsten Bedingungen einen isolirten Wurm beobachtet, die Trichinen als solche im Fleische nicht mit unbewaffnetem Auge zu erkennen sind, und daß das, was man bequem mit bloßem Auge sehen kann, eigentlich die Kapseln sind. Betrachten wir daher zunächst diese letzteren.

Wenn eine junge Trichine in eine Muskelfaser hineingekrochen ist, so bewegt sie sich, wie es scheint, in der Regel eine gewisse Strecke fort. Sie durchbricht dabei die feineren Bestandtheile des Faserinhaltes und wirkt wahrscheinlich schon dadurch zerstörend auf die innere Zusammensetzung der Faser. Aber es läßt sich auch nicht bezweifeln, daß sie von dem Inhalt derselben selbst Theile in sich aufnimmt. Sie hat Mund, Speiseröhre und Darm; sie wächst im Laufe weniger Wochen um ein

Vielfaches, vielleicht um das Dreißig- oder Vierzigfache; sie muß also Nahrung aufnehmen und diese kann sie nicht anderswoher beziehen, als aus der Umgebung, in der sie sich befindet. Wenn sie auf diese Weise die Muskelsubstanz, den Fleischstoff unmittelbar angreift, so wirkt sie zugleich reizend auf die umliegenden Theile.

Um diese Wirkungen zu verstehen, muß man sich die Zusammensetzung des Fleisches (der Muskeln) vergegenwärtigen. Schon für das bloße Auge besteht alles Fleisch aus kleinen, parallel neben einander gelagerten und durch ein zartes Bindegewebe zusammengehaltenen Faserbündeln. Jedes Bündel läßt sich mit feinen Nadeln leicht in kleinere Bündelchen und diese wieder in einzelne Fasern zerlegen. Mikroskopisch zeigt sich auch die einzelne Faser wieder zusammengesetzt. Außen besitzt sie eine strukturlose, cylindrische Hülle; in dieser liegt der eigentliche Fleischstoff, der seinerseits aus kleinsten Körnchen besteht. Diese Körnchen sind der Länge nach in Form von allerfeinsten Fäserchen (Primitivfibrillen), der Breite nach in Form von Plättchen (Fleischscheiben) angeordnet. Zwischen ihnen befinden sich in kleinen Abständen gewisse, mit Kernen versehene Gebilde, die sogenannten Muskelkörperchen. Bei einer stärkeren Vergrößerung stellt sich sonach die einzelne Faser als ein sehr zusammengesetztes Gebilde, gewissermaaßen als ein von einer gemeinschaftlichen Hülle oder Haut umfaßtes Bündel von Fäserchen (Primitivfibrillen) dar, und das ist der Grund gewesen, weshalb die deutschen Anatomen die „Faser" mit dem Namen des Primitivbündels belegt haben.

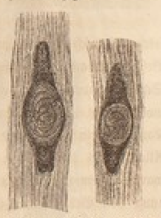
Die zerstörende Wirkung, welche die Trichinen ausüben, gibt sich nun hauptsächlich an dem eigentlichen Fleischstoff und zwar wesentlich an den Körnchen, Primitivfibrillen und Scheiben kund. Diese verschwinden im größten Theile der Faser mehr und mehr, und die letztere magert in dem Verhältniß dieses Schwindens ab. Die reizende Wirkung hingegen tritt am

meisten an der Hülle und an den Muskelkörperchen, namentlich an den Kernen derselben hervor, am stärksten an der Stelle, wo das Thier dauernd liegen bleibt. Die Hülle verdickt sich hier allmählich, die Kerne der Muskelkörperchen vermehren sich, die Körperchen selbst vergrößern sich, zwischen ihnen lagert sich eine derbere Substanz ab, und so entsteht nach und nach um das Thier herum eine festere und dichtere Masse, an welcher man noch lange die äußere Hülle und die innere Wucherung unterscheiden kann.

Je größer das Thier wird, um so mehr rollt es sich ein, indem es Kopf- und Schwanzende einkrümmt und, wie eine Uhrfeder, spiralförmig zusammengewickelt liegt. In der Regel berührt diese Spirale an einem gewissen Theile ihres Umfanges die Faserhaut oder Hülle unmittelbar, während über und unter dieser Stelle die aus der Wucherung des Inhaltes hervorgehende Masse liegt [1]). Hier ist daher die Kapsel von Anfang an dicker und weniger durchsichtig.

Diese Vorgänge bilden sich hauptsächlich in der 3. bis 5. Woche nach der Einwanderung aus. Von da an nimmt die Dicke der Kapsel mehr und mehr zu, und zwar verdichtet sich insbesondere der Inhalt, weniger die Hülle. Der mittlere Theil der Kapsel, wo eben das aufgerollte Thier liegt, erscheint bei mässiger Vergrößerung wie eine helle, kugelige oder eiförmige Masse (vergl. die nebenstehende Abbildung), in welcher man das Thier deutlich wahrnimmt. Ueber und unter dieser Stelle finden sich in der Regel zwei Anhänge, welche bei durchfallendem Lichte dunkler, bei auffallendem Lichte weißlich

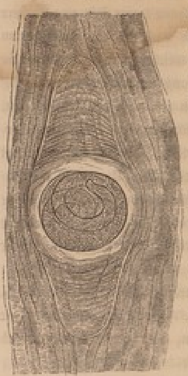
Fig. 1.



[1]) Man vergleiche in der Tafel bei Fig. 3, a.

erscheinen und sich allmählich verdünnen, um in einiger Entfernung mit einem abgerundeten oder abgestumpften Ende aufzuhören. Häufig haben sie die größte Aehnlichkeit in der Form mit

Fig. 2



dem Ausschnitt des inneren Augenwinkels. Sie sind von sehr verschiedener Länge, und auch an derselben Kapsel nicht selten ungleich. Zuweilen fehlen sie ganz, und die Kapsel bildet ein ganz einfaches Oval oder sie ist an den Enden abgestumpft (Fig. 3), oder selbst eingedrückt. Diejenigen Theile der früheren Muskelfaser, welche über sie hinausliegen, verkümmern inzwischen, dagegen sieht man in dem umliegenden Bindegewebe manchmal eine starke, wie entzündliche Wucherung, selbst mit Entwickelung neuer Gefäße.

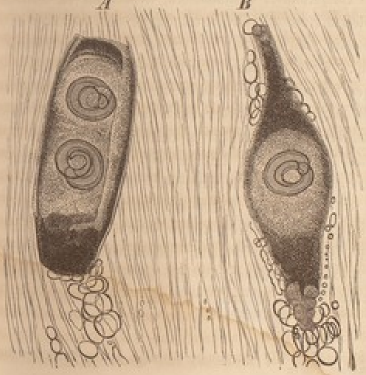
Ueber diesen Umwandlungen vergehen Monate. Betrachtet man solches Fleisch mit bloßem Auge, so vermag man kaum etwas Besonderes an ihm wahrzunehmen. Höchstens wenn man feine Schnitte davon macht und diese mit Essig oder Lauge betupft, wodurch sie durchscheinend werden, treten an den Stellen der Kapseln kleine, weißliche, etwas undurchsichtige Punkte hervor. Allein diese sind, wenn die Einwanderung nicht sehr zahlreich war, keineswegs so charakteristisch, daß man daran ohne Anwendung von Vergrößerungsgläsern mit Sicherheit den gefährlichen Zustand zu erkennen vermöchte. Vielmehr muß man sich wohl vor Täuschungen hüten. Kleine Fettläppchen, die nicht selten im Fleisch vorkommen, Durchschnitte von Gefäßen, Nerven oder

sehnigen Strängen, selbst anderweitige parasitische Einlagerungen können dasselbe Bild hervorbringen, und erst bei einer gewissen Vergrößerung sieht man deutlich, um was es sich handelt.

Die dazu nothwendige Vergrößerung ist keineswegs eine starke. Schon bei einer 10- bis 12maligen vermag man das Verhältniß deutlich zu übersehen und sowohl Kapsel, als Thier zu erkennen. Eine 50-, 100fache oder eine noch stärkere ist freilich sehr viel vorzuziehen, insofern dabei jede Möglichkeit der Täuschung ausgeschlossen ist.

Vergeht eine noch längere Zeit nach der Einwanderung, so geschehen weitere Veränderungen an den Kapseln. Die gewöhnlichste ist die, daß sich Kalksalze ablagern, oder, wie man wohl sagt, daß die Kapseln verkreiden. Früher glaubte man vielfach, daß die Thiere selbst verkreideten. Dieß ist fast nie der

Fig. 3.



Fall. In der Regel beginnt die Verkreidung an der verdickten Inhaltsmasse, während die eigentliche Hülle zunächst noch frei bleibt. Die Kalksalze treten in Form sehr feiner Körnchen auf, welche bei auffallendem Lichte weiß, wie Kreide, bei durchfallendem Lichte (wie es gewöhnlich bei Mikroskopen angewendet wird) dunkel, schattig oder geradezu schwarz aussehen. Nimmt die Kalkmasse sehr zu, so überzieht sie endlich das ganze Thier und man kann auch unter dem Mikroskop von demselben nichts mehr wahrnehmen, selbst wenn es ganz unversehrt ist. Es steckt dann in einer Kalkschale, wie ein Vogelei.

Ist der Mensch, in welchen die Trichinen eingewandert sind, gut genährt, so tritt dazu noch eine andere Veränderung. Es lagert sich nämlich außen um die Kapsel, namentlich um ihre Anhänge oder Fortsätze, Fettgewebe ab [1]). Erreicht diese Ablagerung eine gewisse Stärke, so bildet sich über und unter der Kapsel ein förmliches Fettklümpchen, welches für die Betrachtung mit bloßem Auge die Stelle der Kapsel noch deutlicher hervertreten läßt, als es durch die kreidige Ablagerung ohnehin der Fall ist. Denn von dem Augenblick an, wo die letztere in einer gewissen Reichlichkeit erfolgt, wird die Kapsel für das bloße Auge als ein weißer Punkt sichtbar, und das ist gerade der Zustand, auf welchen sich fast alle älteren Beobachtungen beziehen (S. 7).

Auf der beigefügten Tafel in Fig. 1 ist dieser Zustand von einem menschlichen Muskel dargestellt. Man sieht an der Oberfläche des rothen, der Länge nach durch seine Bündel streifig erscheinenden Fleischstückes, wie es für das bloße Auge aussieht, eine gewisse Zahl rundlicher oder eiförmiger Punkte, an denen bei recht genauer Betrachtung noch die hellere, mehr durchscheinende Mitte zu erkennen ist, welche der Lage des eigentlichen Wurms

[1]) In Fig. 3 (S. 17) sieht man die Fettzellen an den Enden der Kapseln als rundliche Blasen.

entspricht (verg. die Holzschitte 1 und 2 auf S. 15 und 16). Es war dies ein geheilter Fall, in welchem die Kalkablagerung (Verkreidung) sich auf die beiden Anhänge beschränkte. Geht dieselbe über die ganze Kapsel fort, so wird die letztere natürlich noch mehr sichtbar.

Betupft man solches Fleisch mit einer starken Säure, z. B. mit Essigsäure, noch besser mit schwacher Salzsäure, so löst diese die Kalksalze auf, und die weiße Stelle verschwindet zum größten Theile. Indeß ist dieser Versuch etwas unsicher, sobald man an großen Fleischstücken operirt, denn die Säuren erzeugen leicht gewisse Niederschläge aus dem Fleischsaft und machen dadurch die ganze Oberfläche trüb und undeutlich. Am besten verfährt man daher so, daß man kleine Stücke mit einer feinen Scheere abschneidet, diese mit Nadeln zerzupft und die Kapseln so viel als möglich aus dem Fleische frei macht. Nimmt man diese Zerstückelung auf einem Glase vor, welches auf einer dunkeln Fläche liegt, so kann man die Kapseln als weiße Körnchen deutlich sehen und die lösende Einwirkung der Säure gut verfolgen.

Natürlich ist auch diese Untersuchung sehr viel sicherer, wenn man sich nicht auf das bloße Auge beschränkt, sondern ein Vergrößerungsglas zu Hülfe nimmt. Indeß ist für jemand, der einige Erfahrung besitzt, das Bild der verkreideten Kapseln so charakteristisch, daß eine Verwechselung unmöglich ist. Für die Fleischschau genügt es in einem solchen Falle vollkommen, das Fleisch sorgfältig zu betrachten, und falls sich weiße Punkte darin zeigen, den Versuch in der angegebenen Weise mit der Säure zu machen. Klären sich die weißen Punkte durch die Säure auf, so ist die Sache sicher; bleiben sie dagegen weiß, so ist die Wahrscheinlichkeit vorhanden, daß Fettklümpchen, Durchschnitte von Nervenfasern oder Aehnliches zugegen sind. Dabei muß man sich aber wohl erinnern, daß auch neben den verkalkten Kapseln Fettklümpchen sein können und daß daher der negative Erfolg des Versuches weniger beweiskräftig ist, als der positive. Dieß gilt insbesondere für die Fälle, wo wenige Trichinen vorhanden sind. Denn gerade da tritt am häufigsten Heilung und in Folge davon Verkreidung und Fettablagerung ein; auch ist das ganze Bild dann weniger charakteristisch. Es versteht sich daher von selbst, daß hier eine Untersuchung mit Hülfe von Vergrößerungsgläsern allein eine genügende Sicherheit gewährt.

Ich muß hier noch eines besonderen Falles gedenken. Schon vor längerer Zeit hatte Miescher[1]) in den meisten Muskeln einer Hausmaus eigenthümliche, schon mit bloßem Auge sichtbare, weiße Streifen bemerkt, welche bei der mikroskopischen Untersuchung sich als cylindrische Schläuche erwiesen. Jeder Schlauch enthielt eine Menge kleiner länglicher, nierenförmiger oder rundlicher Körperchen, von denen es zweifelhaft blieb, ob sie parasitischer Natur seien oder eine bloße Krankheit der Muskeln darstellten. Später hat v. Heßling[2]) dieselben Gebilde beim Reh, namentlich aber im Herzfleisch des Ochsen, des Kalbes und besonders des Schaafes gefunden; v. Siebold und Bischoff[3]) beobachteten sie bei Ratten. Neuerlichst wurden mir aus Aschersleben Fleischstücke vom Schwein durch die Herren Dr. Gründler und Archidiaconus Ad. Schmidt nebst Zeichnungen des letzteren übersendet, welche sich auf dieselben Gebilde beziehen. Ich habe mich bei der Untersuchung überzeugt, daß sie mit denen des Schaafherzens im Wesentlichen übereinstimmen, und es ist mir kein Zweifel darüber geblieben, daß es sich nicht um ein krankhaftes Erzeugniß, sondern um parasitische Gebilde handelt. Allein ich

[1]) Miescher, in dem Bericht über die Verhandlungen der naturforschenden Gesellschaft in Basel. 1843. S. 143., vgl. die Abbildungen bei v. Siebold in der Zeitschr. für wiss. Zoologie Bd. V. Taf. X. Fig. 10–11.

[2]) v. Heßling, Zeitschrift für wiss. Zoologie Bd. V. S. 196.

[3]) Ebendaselbst S. 201.

bin nicht zu einem Abschluß darüber gelangt, ob es, wie v. Siebold meint, pflanzliche, den schimmelartigen Entophyten zuzuzählende oder thierische Körper sind. Am meisten scheinen sie einer gewissen Form der Psorospermien und Gregarinen nahe zu stehen. Jedenfalls haben die Schläuche, in denen sie sich finden, häufig eine große Aehnlichkeit im Aussehen für das bloße Auge mit Trichinenkapseln, und ich erwähne sie daher hier, um Verwechselungen zu vermeiden. Ob sie schädlich sind und Gefahren bringen, vermag ich nicht zu beurtheilen; bis jetzt liegen keine Anhaltspunkte dafür vor. Indeß können weitere Beobachtungen dieselben herausstellen. Für jetzt mag es genügen, zu erwähnen, daß diese Schläuche sich dadurch von Trichinen unterscheiden, daß sie bis jetzt wenigstens nie verkreidet gefunden sind, daß die Kapsel nicht den Muskeln anzugehören scheint, und daß sich in ihnen keine Würmer, sondern eben nur die erwähnten, sehr kleinen, ei- oder nierenförmigen Körperchen finden. Es beweist aber dieser Befund auf das Klarste, daß nur das Mikroskop bei der Prüfung des Fleisches entscheidend sein kann.

Kehren wir nun zu den Trichinen zurück, so fragt es sich weiter, wenn man ihre Anwesenheit feststellen will:

Wo soll man untersuchen? von welchen Stellen soll man das Fleisch nehmen? Selbst in Fällen schwacher Trichinenerkrankung kommt darauf nicht viel an, denn die Trichinen finden sich in der Regel an allen möglichen Muskeln, an den kleinsten, wie an den größten, an denen des Rumpfes, wie an denen des Kopfes und der Glieder. Nur eine Muskelmasse pflegt eine Ausnahme zu machen, nämlich das Herz, und daher kann man sagen, daß der Genuß des Herzfleisches überall mit der größten Sicherheit zugelassen werden kann.

Wenn aber auch die Trichinen sich über alle möglichen Muskeln verbreiten und sich an allen möglichen Theilen derselben vorfinden, so pflegen sie doch an gewissen Stellen derselben reichlicher zu sein. Dieß sind die **Enden der Muskeln**, diejenigen Abschnitte derselben, welche dicht vor ihrem Ansatze an Sehnen oder Knochen liegen. Besonders deutlich sind die sehnigen Ansätze. In der nebenstehenden Figur ist ein Theil eines Wadenmuskels vom Menschen gezeichnet, der diese Anhäufung der Trichinen um den sehnigen Ansatz deutlich zeigt. Die weißen, leichtstreifigen Stellen bezeichnen die Sehne, die dunklen, dichter gestreiften den Muskel. Rings um den Ansatz des letzteren, in einer geringen Entfernung von dem Ende der dunklen Masse sieht man den dichten Kranz der Trichinenkapseln.

Fig. 4.

Diese eigenthümliche Erscheinung dürfte sich daraus erklären, daß die größere Zahl der Trichinen auf ihrer Wanderung in den Primitivbündeln der Muskel bis gegen die Enden derselben vordringt und erst da Halt macht, wo sich ihrer Weiterwanderung gewisse Widerstände entgegenstellen. Für die Erkenntniß der Krankheit beim Menschen folgt daraus die wichtige praktische Forderung, daß, wenn man ein Theilchen des Muskels behufs einer genaueren Untersuchung des Falles herausschneiden oder reißen will, man am zweckmäßigsten in der Nähe des Muskelansatzes operirt.

Alles bisher Gesagte bezieht sich überwiegend auf eingekapselte Trichinen, bei denen womöglich schon Verkreidung stattgefunden hat. **Wie soll man nun aber die nicht eingekapselten oder die in der Einkapselung begriffenen Thiere erkennen?**

Dieß ist ohne Vergrößerungsgläser ganz und gar unmöglich. Allerdings habe ich mich überzeugt, daß, wie schon oben erwähnt, eine ausgewachsene Fleischtrichine, wenn sie ganz frei und eingerollt liegt, mit bloßem Auge als weißer Punkt zu erkennen ist.

Aber zu erkennen, daß dieser Punkt ein Thier ist, das würde ich mir nicht getrauen. Die Bewegungen, welche ein aus dem Fleisch freigemachtes Thier macht, sind äußerst langsam und wenig ausgiebig. Ortsveränderungen des ganzen Thieres kommen dabei fast gar nicht vor, wenn nicht ungewöhnlich günstige Bedingungen vorhanden sind; gewöhnlich beschränkt sich das Thier darauf, seinen Ring oder seine Spirale etwas zu erweitern und wieder zu verengern, wie eine sich bewegende Uhrfeder. Allein die Excursionen dieser Bewegungen sind so gering, daß sie sich dem bloßen Auge entziehen. Streckt sich das Thier aber wirklich in seiner ganzen Länge aus, so wird es gewiß unsichtbar, weil dann der sehr schmale, äußerst durchsichtige Leib dem Durchgang des Lichts fast gar keinen Widerstand bietet.

Man muß also zum Vergrößerungsglase greifen. Am besten geht man dabei so vor, daß man mit einem scharfen Messer ein feines Fleischbündelchen abträgt, dieses auf ein reines Glasstück ausbreitet, einen Tropfen Wasser darauf bringt, dann ein zweites, womöglich recht dünnes Glas darüber legt und etwas andrückt, und nun das Ganze unter das vergrößernde Instrument bringt.

Ein solches Fleischbündelchen ist auf der beifolgenden Tafel in Figur 2 abgebildet, wie sich seine Größe für das bloße Auge darstellte. In Figur 3 ist dasselbe Stück bei einer etwa 50maligen Vergrößerung gezeichnet. Man sieht, daß darin gegen 60 Trichinen enthalten sind. Die meisten von ihnen liegen noch in ihrer spiraligen Einrollung; einzelne sind durch den Schnitt ganz oder zum Theil frei geworden und haben sich in verschiedener Weise ausgestreckt. Unten bei a ist eine Trichine in der durch ihre Anwesenheit blasig aufgetriebenen Muskelfaser gezeichnet. Es ist ein Stück Muskel vom Menschen in einem Falle, wo der Tod durch die starke Einwanderung der Trichinen erfolgt war (aus der Epidemie von Burg).

Hier handelt es sich demnach nicht mehr um Kapseln, sondern um die Thiere selbst, und es ist daher zum vollen Verständniß nöthig, noch einige Bemerkungen über dieselben hinzuzufügen.

Fig. 5.

Eine vollkommen ausgewachsene, ältere Muskeltrichine, wie sie in Fig. 5 abgebildet ist bei einer 300maligen Vergrößerung, stellt sich als ein, der Gestalt nach einem Regenwurm vergleichbarer Rundwurm dar.[1]) Sie besitzt ein vorderes, zugespitztes Ende a, an welchem sich die Mundöffnung befindet, und von welcher im Innern eine feine Röhre, die Speiseröhre, abgeht. Diese umgibt sich sehr bald mit einem dicken Zellenkörper c, der durch einen großen Theil des Leibes reicht und bei d in einen feineren Darm sich fortsetzt. Letzterer erstreckt sich bis zum hinteren, etwas dicken Leibesende b, wo er sich nach außen öffnet. Bei e sieht man einen dunklen Körnerhaufen; dieser liegt in dem Geschlechtskanal, welcher den größeren Theil des hinteren Leibesabschnittes füllt, aber weiter nichts Deutliches wahrnehmen läßt. Diese beiden Hauptapparate, der Verdauungs- und der Geschlechtsapparat, sind umschlossen von einer derben, äußeren Haut, welche feine Querrunzeln zeigt.

Es handelt sich, wie man sieht, hier um ein recht gut organisirtes Thier aus der Klasse der eigentlichen Würmer, dessen innere Einrichtung wegen der Durchsichtigkeit seiner äußeren Haut klar erkannt werden kann. Aber freilich ist eine solche Klarheit

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[1]) Hr. J. Kaminer (Alexanderstr. 1) hat in letzter Zeit photographische Abbildungen davon angefertigt.

nur erreichbar, wenn man ein gutes Mikroskop und eine Vergrößerung bis zu etwa 300mal anwenden kann. Bei unvollkommenen Instrumenten und schwachen Vergrößerungen sieht man nicht viel mehr, als die äußere Gestalt des Wurmes. Für die gewöhnlichen Zwecke genügt dieß aber vollständig, sowohl für die Fleischschau, als für die Erkenntniß des Falles einer Erkrankung, denn die Möglichkeit einer Verwechselung liegt in keiner Weise vor. Namentlich muß ich besonders bemerken, daß es keinerlei Art von Maden gibt, welche irgend eine Aehnlichkeit damit besäße. Insbesondere die gewöhnlichen Fliegen- und Mückenlarven unterscheiden sich nicht bloß durch eine ganz andere Gestalt, sondern noch weit mehr durch ihre viel beträchtlichere Größe, und wenn unverständige Metzger oder andere Laien die Meinung aufstellen, die ganze Trichinen-Angelegenheit sei nur auf unschädliche Maden zurückzuführen, so ist das ein bedauerliches Zeichen krasser Unwissenheit und höchsten Leichtsinns.

Trichinen der beschriebenen Art finden sich in Fällen frischerer Einwanderung ziemlich lose in dem Fleische, und wenn man in der angegebenen Weise feine Schnitte macht und sie auf einem Glase in einen Wassertropfen legt, so schwimmt gewöhnlich eine gewisse Zahl von Thieren neben dem Fleisch umher. Aber dieselben Thiere sind auch in den Kapseln bei älteren Fällen vorhanden, selbst wenn die Kapseln verkreidet sind, und man kann sie aus denselben durch einen mäßigen Druck leicht frei machen. Gerade wenn die Verkalkung nicht vollständig ist und die Kapseln eine gewisse Starrheit und Zähigkeit erlangt haben, so zerplatzen sie unter leichtem Druck sehr bald, und das Thier tritt hervor. Hat man das Fleischschnittchen, wie früher angegeben, mit einem dünnen Gläschen bedeckt, so genügt es, auf dieses etwas zu drücken, um die Thiere aus den Kapseln hervorzupressen.

Es ergibt sich aus dieser Darstellung, daß eine eigentliche Erkenntniß der Trichinen als solcher immer die

Anwendung von Vergrößerungsgläsern voraussetzt, und daß nur bei stärkerer Ausbildung und endlicher Verkreidung der Kapseln mit dem bloßen Auge die Erkenntniß dieser Kapseln und insofern mittelbar auch der Trichinen möglich ist.

2) Welche Gefahren für den menschlichen Körper werden durch die Trichinen bedingt?

In der geschichtlichen Einleitung ist schon erwähnt, daß mehr als zwei Decennien seitder Entdeckung der Trichinen vergingen, ohne daß man ihnen irgend eine gefährliche Einwirkung auf den menschlichen Körper zuschrieb. Ich habe auch schon die Erklärung hinzugefügt, daß man damals immer nur geheilte Fälle beobachtete. Dazu kam, daß selbst solche Fälle sehr selten beobachtet wurden. Es vergingen Jahre, ohne daß ein einziger neuer Fall bekannt wurde, und noch bis auf diesen Tag ist in Frankreich nur eine einzige Beobachtung, in vielen anderen Ländern keine einzige veröffentlicht worden.

Ich habe zuerst darauf hingewiesen, daß bei einer sorgsamen Beobachtung eine sehr viel größere Häufigkeit des Vorkommens nachzuweisen ist. In einem einzigen Jahre, 1859[1]), fand ich ein halbes Dutzend Mal die Thiere in menschlichen Leichen, und sehr bald hatte ich viel mehr Fälle davon gesehen, als in 30 Jahren in der gesammten Literatur der Welt verzeichnet waren. So kann ich erwähnen, daß allein im letzten November vier neue Fälle bei Leuten vorkamen, die in der Charité gestorben waren. Andere Beobachter haben ähnliche Resultate gehabt.

Dabei ist wohl zu beachten, daß alle diese Fälle erst bei der Section erkannt wurden, ohne daß bei Lebzeiten der Kranken irgend eine Ahnung ihres Zustandes bestanden hatte. Alle bezogen

[1]) Mein Archiv. Bd. XVIII. S. 330.

sich auf eingekapselte Trichinen, waren also alte, eigentlich schon abgelaufene Fälle, aber sie haben nichtsdestoweniger eine große Bedeutung, weil sie darthun, daß die Möglichkeit der Gefahr, die wir aus anderen Fällen erkennen, oft genug an den Menschen herantritt.

Allein diese Erfahrungen würden nicht genügt haben, das allgemeine Interesse zu erregen, wenn nicht endlich Fälle von frischer Einwanderung und von nicht eingekapselten, noch freien Trichinen bekannt geworden wären, wenn man dadurch nicht auf die Quellen der Einwanderung hingeführt und wenn endlich nicht gruppenweise Erkrankungen, sogenannte Epidemieen, ja sogar Todesfälle in Folge der Anwesenheit von Trichinen im menschlichen Leibe festgestellt worden wären.

Es ist das Verdienst von Zencker[1]), daß er zuerst in und bei Dresden eine solche Epidemie feststellte und zugleich in dem Schinken, der Cervelat- und Blutwurst, welche von einem bestimmten Schweine noch vorhanden waren, die Anwesenheit der Trichinen nachwies. Das Schwein war auf einem Landgute bei Dresden geschlachtet worden; der Metzger, der Gutsbesitzer, die Wirthschafterin, andere Leute waren schwer erkrankt, und ein vorher ganz gesundes Dienstmädchen war gestorben. An ihrer Leiche wurde eine förmliche Ueberschwemmung mit Trichinen dargethan. Ich selbst erhielt durch die Güte des Herrn Zencker sowohl von dem Schinken, als von den Muskeln des Mädchens, und hatte so Gelegenheit, nicht nur die Zuverlässigkeit der Beobachtung zu bestätigen, sondern auch eine Reihe von Versuchen an Thieren anzustellen. Letztere will ich hier kurz zusammenfassen:

Ein Kaninchen, welches mit Trichinen von dem Mädchen gefüttert war, starb nach einem Monate, nachdem sein Fleisch sich mit Thieren erfüllt hatte. Von diesem Fleisch gab ich einem

[1]) Mein Archiv. Bd. XVIII. S. 561.

zweiten zu fressen; es starb wieder nach einem Monate. Mit seinem Fleisch wurden 3 neue Kaninchen gefüttert, zwei starben nach 3, eins nach 4 Wochen. Von letzterem wurde wieder Fleisch gefüttert; das betreffende Thier, welches nur wenig Fleisch erhalten hatte, ging nach 6 Wochen zu Grunde. Bei allen waren die Muskeln überfüllt mit Trichinen, so daß in jedem, noch so kleinen Fleischstückchen mehrere davon angetroffen wurden.

Um ganz sicher zu sein, daß nicht etwa ein Zufall hier mitspiele, untersuchte ich bei mehreren dieser Kaninchen einzelne Theile ihrer Muskeln mikroskopisch, bevor die Fütterung vorgenommen wurde. Es fand sich keine Spur von Trichinen, wie denn überhaupt bis jetzt bei Kaninchen ohne vorhergegangene künstliche Fütterung noch nie derartige Thiere beobachtet sind. Mehrere Wochen nach der Fütterung waren dieselben Muskeln, von welchen ich vor der Fütterung festgestellt hatte, daß sie frei waren, voll von Trichinen.

So überzeugend diese durch 5 Generationen hindurch fortgeführten, jedesmal zum Tode führenden Ansteckungen auch sein mögen, so ließe sich doch auch hier noch ein Zufall denken. Um diesen auszuschließen, blieb also nur noch der Nachweis zu liefern übrig, daß wirklich von den gefütterten Trichinen die Einwanderung ausging. Auch dieß konnte sicher dargethan werden.

Es ließ sich nachweisen, daß aus dem gefütterten Fleische die Trichinen im Magen und Dünndarm der Kaninchen sehr bald frei werden und sich zu männlichen und weiblichen, geschlechtsreifen Thieren ausbilden, welche in kurzer Zeit eine Länge von 3—4 Millimeter erreichen und dann als feine weiße Fädchen mit bloßem Auge sichtbar sind. In den mütterlichen Thieren entwickeln sich Eier und aus diesen Junge noch innerhalb des Körpers der Mutter, welche später (etwa eine Woche nach der Befruchtung) ausschlüpfen und frei im Darmschleim sich bewegen. Die Trichinen sind also lebendig gebärende Thiere.

Die Jungen sind von der äußersten Kleinheit und Feinheit. Sie sind Fadenwürmchen, wie man sie kleiner kaum kennt. Sie sind es, welche vom Darm aus in den Körper einwandern. Ich habe sie nachher in den Lymphdrüsen des Gekröses, in der Bauchhöhle, im Herzbeutel und in den Muskeln wieder gefunden. In den letzteren allein treffen sie eine für ihr weiteres Wachsthum geeignete Wohnstätte. Hier wachsen sie und in 3—4 Wochen haben sie schon wieder die Größe erreicht, welche ihre Mütter und Väter zur Zeit der Fütterung hatten.

Diese Versuchsreihe, welche ich in der Sitzung der Pariser Akademie der Wissenschaften vom 2. Juli 1860 mittheilen ließ konnte über die Geschichte und Bedeutung der Trichinen keinen Zweifel mehr lassen. Ich selbst habe die Versuche später mehrmals wiederholt und auch andere Untersucher haben Aehnliches gethan. Nimmt man dazu die an Menschen gemachten Beobachtungen, welche sich mit jedem Jahre mehren, so ist es eine Thorheit, um nicht zu sagen, ein Verbrechen, noch von einer ungegründeten Trichinenfurcht (Trichinophobie) zu sprechen.

Eine ganze Reihe gruppenweiser, wie man sagt, epidemischer Erkrankungen ist sicher festgestellt. Ich erwähne nur die Epidemieen von Plauen [1]), Calbe an der Saale [2]), Quedlinburg [3]), Burg bei Magdeburg, Weimar und Hettstädt bei Eisleben, sowie den sehr merkwürdigen Fall, der auf einem Hamburger Schiffe vorgekommen ist [4]). Mehrere andere Epidemien, welche sehr wahrscheinlich auf Trichinen zurückzuführen sind, lasse ich unerwähnt,

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[1]) Böhler, die Trichinenkrankheit und die Behandlung derselben in Plauen. 1863.

[2]) G. Simon, Preußische Medizinal-Zeitung. 1862. Nr. 38—39.

[3]) Behrens, Deutsche Klinik. 1863. Nr. 30.

[4]) Tüngel. Mein Archiv. 1863. Bd. XXVII. S. 421.

da keine mikroskopische Untersuchung vorgenommen oder wenigstens kein definitives Resultat erreicht worden ist.

In jenen Epidemieen handelt es sich zum Theil um sehr zahlreiche Erkrankungen. 20, 30 Personen, ja in dem traurigen Fall von Hettstädt fast anderthalb hundert Personen erkrankten, viele sehr schwer, und die Zahl der Todesfälle überstieg in Hettstädt 20 [1]). Ein Zweifel ist hier gänzlich ausgeschlossen. Die zuverlässigsten Beobachtungen liegen vor; ich selbst habe sowohl aus der Epidemie von Burg, als aus der von Hettstädt Muskelfleisch untersucht, welches von Trichinen vollgestopft war.

Es kann nicht in der Aufgabe dieses Schriftchens liegen, die Krankheitserscheinungen hier ins Einzelne zu verfolgen. Es mag genügen, zu erwähnen, daß dieselben sich verschieden darstellen. Bald sind es überwiegend Erscheinungen der Darmreizung, Darmkatarrhe, ruhrartige Zufälle, „gastrische" Störungen, bald Erscheinungen des Muskelleidens, Schwäche, Mattigkeit, Steifheit, Schmerzhaftigkeit, wie bei Gicht oder Rheumatismus, bald fieberhafte Zufälle, wie bei Typhus und Nervenfieber u. s. f. Zuweilen entwickeln sie sich äußerst acut, und der Tod erfolgt in der Regel in der 4. oder 5. Woche; zuweilen nehmen sie einen mehr schleichenden Verlauf und es tritt nach Wochen eine langsame Genesung ein, welche aber in chronisches Siechthum mit Abmagerung und Verfall der Kräfte ausgehen kann. Ein paar Mal habe ich die Leichen von Leuten untersucht, von denen man vorausgesetzt hatte, daß sie an Schwindsucht gestorben seien; die Section ergab neben einer sehr mäßigen Lungenaffection sehr verbreitete Trichinen und die äußerste Abmagerung der Muskeln.

Für den erfahrenen Arzt haben diese Erkrankungen manches Eigenthümliche, wodurch sie sich von gastrischen und nervösen

[1]) Bis zum 23. Novbr. waren 137 Erkrankungen und 24 Todesfälle constatirt.

Fiebern, von Gicht und Rheuma unterscheiden, aber ein ganz sicheres Urtheil wird auch für den Arzt erst gewonnen, wenn die Trichinen entweder in dem Fleisch, wovon die Erkrankten genossen haben, oder in dem Fleisch der Erkrankten selbst nachgewiesen werden. Letzteres ist natürlich nur möglich, wenn durch eine kleine Operation Muskelstückchen für die Untersuchung gewonnen werden, was durchaus ungefährlich ist. Ohne die Feststellung der Thiere bleibt man oder blieb man wenigstens früher gewöhnlich bei der Annahme einer Vergiftung stehn.

Seit dem Jahre 1860 habe ich mich mit manchem Anderen bemüht, die Kenntniß dieser Thatsachen zu fördern und die Aufmerksamkeit auf die Gefahren hinzulenken, welche ein unvorsichtiger Genuß von Schweinefleisch mit sich bringen kann. Von Anfang an hat sich dagegen die Opposition der Metzger erhoben und noch in diesen Tagen ist dieselbe nicht überall gebrochen. Ich bemerke daher vorweg, daß gerade die Metzger das allergrößte Interesse haben sollten, jede Vorsicht anzuwenden, da sie nicht bloß in ihrem Gewerbe, sondern auch in ihrer Person bedroht sind. Sowohl in mehreren Epidemieen, als auch in einer Reihe von Einzelfällen z. B. in denen von Friedreich [1]), Traube [2]), Tüngel, waren es gerade die Metzger, welche durch das von ihnen geschlachtete Thier angesteckt wurden. Dabei hat man freilich nicht an eine Ansteckung durch die Haut zu denken; eine solche gibt es nicht. Aber die Metzger essen nicht bloß vorzugsweise von dem zubereiteten Fleisch, der Wurst u. s. w., sondern viele von ihnen haben auch die Gewohnheit, etwas frisches Fleisch beim Schlachten zu genießen, wenigstens das Messer abzustreichen, und das Abgestrichene in den Mund zu stecken. Sie stehen also in erster Linie

[1]) Friedreich. Mein Archiv. 1862. Bd. XXV. S. 399.

[2]) G. Schultze, de Trichiniasi. Diss. inaug. Berol. 1863. p. 17.

vor der Gefahr; auf sie folgen erst Köchinnen und Dienstmädchen und weiterhin die übrige Bevölkerung.

Aber auch, nachdem die Trichinenkrankheit beim Menschen nicht mehr bezweifelt werden kann, bemüht man sich auf die gewissenloseste Weise, das an sich so klare Sachverhältniß wieder zu trüben. Schlecht unterrichtete oder übelwollende Personen verbreiten die Behauptung, die Krankheit sei bei dem Schweine noch gar nicht nachgewiesen. Nichts ist unwahrer.

Wie ich im historischen Theile anführte, hat Leidy schon vor 16 Jahren in Nordamerika Trichinen beim Schwein gefunden. Zencker hat sie in dem Schinken und der Wurst des Schweines nachgewiesen, von dem die Erkrankten und die Gestorbene in der Dresdener Epidemie genossen hatten; ich selbst habe von ihm ein Stück des betreffenden Schinkens erhalten und mich von der Anwesenheit der Thiere überzeugt (S. 27). Dasselbe ist bei der Epidemie von Quedlinburg und Hettstädt, dort an Schinken, hier an Wurst nachgewiesen. In Hettstädt steht es fest, daß die große Mehrzahl der Leute in Folge eines gemeinschaftlichen Festessens erkrankten, welches am 18. Octbr. v. J. veranstaltet wurde. Besonders überzeugend ist aber der von Tüngel beschriebene Fall, den ich daher kurz berühren will.

Ein Hamburger Schiff kehrte von Valparaiso nach Hause zurück. Vor der Abfahrt kaufte man dort ein lebendes Schwein. Dieses wurde am 1. April v. J. am Bord des Schiffes geschlachtet: der Schiffskoch besorgte unter Mitwirkung der übrigen Mannschaft das Schlachten. Die Mannschaft verzehrte davon 30 Pfund, das Uebrige wurde eingesalzen. Bei der Einfahrt in den Hafen erkrankten viele, die meisten leicht, einige schwerer. Zwei starben; bei dem einen, einem 16jährigen Schiffsjungen, der am 24. starb, wurden zahlreiche, nicht eingekapselte, lebende Trichinen in den Muskeln gefunden. Das noch vorhandene Pökelfleisch, von dem ich ein Stück erhielt, zeigte dieselben gleichfalls, jedoch todt.

Das Vorkommen der Trichinen bei Schweinen und die Abhängigkeit der Erkrankung der Menschen von dem Genuß solchen Schweinefleisches kann danach nicht mehr zweifelhaft sein. Man hilft sich nun mit dem Troste, daß die Schweine nicht häufig davon befallen würden und daß die befallenen doch bestimmte Krankheitszeichen darbieten müßten.

Was das Erstere anbetrifft, so kann man es glücklicherweise zugeben. Aber was hilft dieser Trost denen, welche das Unglück haben, von einem der wenigen Schweine, welche Trichinen enthalten, zu essen? Ueberdieß läßt sich bis jetzt eine wirklich zuverlässige Statistik nicht geben, da die Beobachtungen, welche vorliegen, dazu nicht ausreichen.

Noch schlechter ist der zweite Einwand. Die sorgfältigen Fütterungsversuche, welche Haubner, Küchenmeister und Leisering[1]) mit trichinischem Fleische an Schweinen anstellten, ergaben freilich, daß einzelne, namentlich jüngere Thiere erkrankten und selbst starben, aber in ihren Schlußergebnissen kommen diese Beobachter doch geradezu zu dem Satze, daß „man beim Schweine von einer eigentlichen, durch sichere und bestimmte Symptome gekennzeichneten Trichinenkrankheit nicht sprechen könne.“ Auch erwähnen alle Berichte über diejenigen Schweine, welche den Ansteckungsstoff für Menschen dargeboten haben, nichts von einer besonderen Erkrankung der Thiere[2]).

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[1]) Haubner, Küchenmeister u. Leisering, Helminthologische Versuche. Dresden 1863. S. 5. (Aus dem Berichte über das Veterinärwesen im Königreich Sachsen für das Jahr 1862.)

[2]) Hr. Dr. Rupprecht in Hettstädt schreibt mir über das Schwein, von dem die dortigen Ansteckungen ausgingen: Es war ein 2¼jähriges, halbenglisches Mutterschwein, welches fünf Fleischern, die darum handelten, völlig gesund erschienen ist. Der sechste hat es gekauft. Es muß auch ihm nicht verdächtig vorgekommen sein, da er und sieben Glieder seiner Familie nach dem Genusse des Fleisches krank wurden; er selbst und sein Dienstmädchen starben.

Aber gesetzt auch, dieselbe komme vor, so wird sie oft genug abgelaufen sein, wenn die Schweine in den Handel kommen und geschlachtet werden. Es sind eben meist Fälle von schon heilenden oder geheilten, also eingekapselten Trichinen, um die es sich handelt. Die wirklichen Krankheitssymptome mögen Wochen oder Monate vorher dagewesen sein und es mag in einzelnen Fällen, bei sehr vorurtheilsfreien und ehrlichen Verkäufern möglich sein, dieß noch zu erfahren, aber in der Regel wird es nicht der Fall sein und jedenfalls wird es keine Sicherheit geben. Bedenkt man, wie viele Schweine, namentlich in größeren Städten, nicht bloß Meilen weit, sondern aus entfernteren Provinzen und Ländern herbeigeführt werden, so muß man zugestehen, daß hier Nachforschungen über die Lebensgeschichte der Schlachtthiere, selbst bei dem besten Willen ganz unmöglich sind.

Nun steht es aber fest, daß die Einkapselung, ja selbst die Verkreidung die Thiere nicht tödtet. Fast in allen Fällen beim Menschen, wo ich verkreidete Kapseln gefunden habe, waren die darin enthaltenen Trichinen noch lebendig. Wie lange Zeit nach der Einwanderung verstrichen war, kann ich nicht angeben, da in keinem dieser Fälle die Zeit der Einwanderung zu ermitteln war. Aber es ist wenigstens sicher, daß Monate vergehen müssen, bevor die Verkreidung beginnt, und es ist höchst wahrscheinlich, daß die Trichinen in einer Art von Scheintod oder Vita minima Jahre lang im Körper verharren können, um nach dem Genusse des Fleisches, in dem sie sich befinden, sofort zu neuer, kräftigerer Lebensthätigkeit zu erwachen. Ich habe wiederholt gerade mit solchen Trichinen, deren Kapseln vollständig verkalkt waren, gelungene Fütterungsversuche angestellt.

So weit bleibt die Gefahr trotz aller Einwände bestehen, und nur die Frage ist nicht bloß erlaubt, sondern geboten, wie es komme, daß die **Zufälle, welche nach dem Genusse**

eintreten, in ihrer Heftigkeit und Bedeutung so sehr verschieden sind? Diese Frage ist bestimmt zu beantworten.

Die Darmerscheinungen (das gastrische Fieber, die ruhrartigen Zufälle) sind abhängig von der Anwesenheit der Thiere im Darm. Diese kann sehr verschieden lange dauern. Wenn Jemand bald nach dem Genusse des betreffenden Fleisches starke Ausleerungen, insbesondere Durchfall bekommt, so kann es sein, daß alle Thiere mit entleert werden. Im anderen Falle wachsen sie, bewegen sie sich und pflanzen sie sich fort, und damit entsteht der krankhafte Reiz. Dieser kann sich aber natürlich auch nach den individuellen Verhältnissen sehr verschieden gestalten; reizbare Personen, welche an sich zu Durchfällen neigen, werden im Ganzen sicherer vor der eigentlichen Infektion sein, als solche, welche zu Verstopfung disponirt sind.

Die Muskel- und Fiebererscheinungen sind abhängig von der Einwanderung der jungen Brut aus dem Darm in den Körper des Kranken. Auch sie werden natürlich von mancherlei individuellen Verhältnissen abhängig sein. Eine gewisse Einrichtung des Darmes mag ihre Einwanderung begünstigen oder fördern. So ist es mir noch nie gelungen, bei Hunden eine Trichinenkrankheit zu erzielen, obwohl die Entwickelung der Trichinen in ihrem Darm sehr gut geschieht, wie sie denn zu allererst von mir bei einem Hunde beobachtet wurde.

Kommt aber die Einwanderung zu Stande, so steht die Gefahr in einem gewissen Verhältnisse zu der Zahl der einwandernden Thiere. Diese kann sehr verschieden sein. Ich habe noch neuerlich Fälle beim Menschen gesehen, wo ich mit vielem Suchen nur ein Dutzend Trichinen aus den Muskeln zusammenbringen konnte, und wieder gibt es andere, wo sie zu Millionen vorkommen. Die schädliche Wirkung summirt sich hier aus den vielen Einzelstörungen, welche die einzelnen Thiere am Orte ihrer Einwanderung hervorbringen. Jemand, der nur ein Dutzend junger

Trichinen aufnimmt, wird möglicherweise gar nichts davon merken; seine Gesundheit wird keinen Augenblick gestört. Ein Anderer, in den vielleicht Tausende einwandern, wird allerlei unangenehme Zufälle, Muskelschmerzen, Steifigkeit, Schwäche, Abgeschlagenheit, Heiserkeit u. dgl. haben, aber er wird diese Zufälle überwinden, indem die eingewanderten Thiere sich einkapseln und endlich verkreiden. So kommt die Heilung zu Stande. Ein dritter endlich, bei dem Millionen einwandern, wird vielleicht auch genesen, aber sehr langsam, und er wird schwach, siech und mager bleiben, oder aber er geneset nicht, sondern geht unter den zunehmenden Störungen aller Muskelthätigkeit, insbesondere auch der athmenden Thätigkeit zu Grunde.

Das begreift sich ja vollständig, wenn man nur nicht die drei Cardinalsätze der Trichinenlehre vergißt:

1) die genossenen Trichinen bleiben im Darm und kommen nicht in die Muskeln,
2) sie erzeugen lebendige Junge, welche in die Muskeln einwandern,
3) die in die Muskeln eingewanderte Brut wächst darin, aber sie vermehrt sich nicht.

Die eigentliche Gefahr liegt also eben in der Erzeugung junger Brut durch die Darmtrichinen. Eine erwachsene Trichinenmutter hat Hunderte von lebendigen Jungen in ihrem Leibe, und hinter diesen Jungen erzeugt sie immer noch wieder neue Eier. Wie lange sie am Leben bleiben und Junge zeugen kann, ist nicht genau bekannt, jedoch dauert dieß wenigstens 4—5 Wochen; das aber wissen wir ganz genau, daß sie gleichsam im Darm vor Anker liegt und immer neue Brut aussetzt. Rechnen wir auch nur 200 Junge auf eine Trichinenmutter, so genügen 25,000 solcher Mütter, um eine Million Junge für die Einwanderung zu liefern, und so viel Mutterthiere können in wenigen Bissen Fleisch enthalten sein, wenn auch noch kein sehr hoher Grad von

Anfüllung desselben vorhanden ist. Ein Blick auf das kleine Muskelstück, welches auf beifolgender Tafel abgebildet ist, genügt, um diese Rechnung zu begründen.

Je mehr Trichinen also genossen werden und je länger sie im Darm verweilen, um so mehr Junge werden geliefert und um so höher steigt die Gefahr. Ich habe dies durch direkte Versuche an Thieren geprüft. Auch ein Kaninchen, das nur kleine Mengen von trichinenarmem Fleisch erhält, erkrankt nicht. In der Epidemie von Burg hat sich dieß auf das Schlagendste bestätigt. Eine Frau, welche rohes Fleisch auf Brod gegessen hatte, starb; ihr kleines Kind, welches den Löffel abgeleckt hatte, mit dem sie das Fleisch aufgestrichen hatte, erkrankte ganz leicht.

Ein Mensch kann also, so gut wie ein Schwein, eine recht erhebliche Zahl von Trichinen aufnehmen und beherbergen, ohne deßhalb zu sterben oder auch nur schwer zu erkranken. Das ist ein kleiner Trost dafür, daß schwerlich jemals ein absolutes Schutzmittel gegen die Aufnahme von Trichinen gefunden werden wird und daß niemals auch eine genaue Untersuchung des Fleisches sich auf jeden einzelnen Theil erstrecken kann.

Aber eben so sicher ist es, daß eine sehr große Einwanderung nothwendig Krankheit und möglicherweise Tod herbeiführt, und das sollte alle Einwände niederschlagen, welche noch gegen eine sorgfältige Fleischschau aufgestellt werden.

Vielfach ist mir auf diese Bemerkung eingeworfen worden, man habe doch früher von solchen Fällen nichts gehört. Wenn wirklich die Gefahr so groß sei, so hätte man doch schon früher ähnliche Beobachtungen machen müssen. Insbesondere solche gruppenweise auftretende Erkrankungen hätten doch nicht wohl unbemerkt bleiben können.

Einzelne haben freilich darauf geantwortet, die Krankheit müsse überhaupt neu und früher noch nicht dagewesen sein. Allein diese Vermuthung wiederholt sich jedesmal, wenn eine bis dahin unbekannte Krankheit durch genauere Forschung erkannt und aus irgend einer größeren Gruppe verwandter Krankheiten losgelöst wird. Ich erinnere nur an eine noch fürchterlichere Krankheit, die ebenfalls vom Thier auf den Menschen übertragen werden kann, an die Rotzkrankheit. Der erste, genau festgestellte Fall davon wurde 1821 von Schilling veröffentlicht, und seitdem vergeht kein Jahr, wo nicht neue Fälle hinzukommen. Wollte man nun schließen, daß der Rotz eine neue Krankheit sei? Die Rotzkrankheit der Thiere wird schon von den alten griechischen und römischen Schriftstellern erwähnt [1]), und nicht der geringste Grund liegt vor, daß sie sich nicht schon vor Jahrtausenden auf den Menschen übertragen habe. Aber es ist schwer zu beweisen, daß gerade dieser oder jener bestimmte Fall, der schon früher geschildert ist, sich auf eine solche Uebertragung bezieht.

Nun ist es ja bekannt, daß schon in den mosaischen Gesetzen [2]) das Schwein für unrein erklärt und der Genuß seines Fleisches verboten wurde. Möglicherweise stützt sich dieses Verbot zunächst auf die Beobachtung, daß das Schwein unreine, zum Theil faulige Nahrung zu sich nimmt, aber darf man nicht auch vermuthen, daß schon damals wirkliche Erkrankungen nach dem Genusse von Schweinefleisch wahrgenommen worden sind? Gerade unter den einfacheren Lebensverhältnissen eines, damals wenigstens noch mehr nomadenhaft lebenden Volkes konnte ja eine gruppenweise Erkrankung leichter auf ihre bedingenden Ursachen zurückgeführt werden. Als man nun in der neuesten Zeit die Entstehung der Bandwürmer des Menschen aus Schweinefinnen festgestellt hatte, nahm man vielfach an, das mosaische Gebot habe besonders auf Bandwürmer Bezug. Aber Bandwürmer erzeugen selten wirkliche Krankheiten, sie sind nicht im eigentlichen Sinne gefährlich, und

[1]) Mein Handbuch der Speciellen Pathologie u. Therapie. Erlangen, 1855. Bd. II. S. 406, 413.

[2]) Moses III. 11, 7. V. 14, 8.

wenn überhaupt das Verbot aus der Erkenntniß wirklicher übertragener Krankheiten hervorging, so liegt es gewiß viel näher, an Trichinen zu denken.

Allerdings erkranken die meisten Menschen nicht unmittelbar nach dem Genusse trichinischen Fleisches. Es gehen Tage darüber hin, und der Verdacht kann sich daher leicht auf ein näher liegendes Ereigniß richten. Indeß, wenn eine größere Zahl von Menschen gleichzeitig erkrankt, so wird doch endlich der Verdacht auf die richtige Quelle geführt werden. So gibt es in der medicinischen, namentlich in der gerichtsärztlichen Literatur, nicht wenige Fälle, wo der Verdacht sich auf Schinken wendete. Aber da man die Trichinen nicht kannte, da man die Muskeln der Gestorbenen nicht einmal bei der gerichtlichen Obduction prüfte, so brachte nicht einmal dieses, sonst so gewissenhaft ausgeführte Verfahren einen Aufschluß. Man blieb schließlich bei der Vermuthung einer Vergiftung stehen, und wenn man bei der chemischen Untersuchung kein mineralisches Gift auffand, so schob man ein organisches unter und nannte dieß Schinkengift.

Gibt es ein Schinkengift? Niemand kann es sagen, denn noch nie ist ein Chemiker im Stande gewesen, es aufzufinden. Die ganze Argumentation bleibt dabei stehen, daß ein anderes Gift nicht nachzuweisen sei und daß doch die Vergiftung da sei. Aber ist diese Vergiftung dargethan? Nein, auch sie ist nur vermuthet, weil eine andere Erklärung nicht vorhanden war. Die Trichinen-Erkrankungen gestatten eine andere Deutung, und es mag genügen, auf ein Paar Fälle hinzuweisen.

Im vorigen Sommer operirte Hr. Langenbeck einen Mann wegen einer Geschwulst am Halse. Während der Operation bemerkte er, daß die bloßgelegten Muskeln voll von verkalkten Trichinen waren. Als der Mann nun gefragt wurde, ob er nicht irgend einmal in besonderer Weise erkrankt sei, erzählte er eine wunderbare Geschichte. Im Jahre 1845 nahm in der Lausitz eine Commission zur Inspektion der Schulen bei einem Wirth ein gemeinschaftliches Mahl (Schinken, Wurst, Käse u. s w.) ein. Ein Mitglied entfernte sich, ohne etwas anderes, als ein Glas Rothwein, genossen zu haben. Die anderen sieben tranken Weißwein und aßen von den aufgesetzten Speisen. Alle sieben, darunter der Operirte, erkrankten und vier starben. Der Verdacht lenkte sich natürlich auf das Mahl und den Wirth. Es wurde eine gerichtliche Untersuchung, zunächst auf den Weißwein, eingeleitet; diese blieb erfolglos, aber der Wirth konnte den Verdacht nicht wieder los werden und sah sich endlich genöthigt, auszuwandern.

Im Juni 1851 erkrankte in der Nähe von Hamburg eine Reihe von Personen in Folge von Schinkengenuß; drei davon starben und mehrere blieben längere Zeit in einem sehr angegriffenen Zustande. Die gerichtliche Untersuchung blieb auch hier ohne Ergebniß, und man nahm daher zuletzt zu dem Schinkengift seine Zuflucht. Der Schinken selbst war noch aufgefunden; man konnte seine Geschichte bis zu dem Metzger zurückverfolgen; es ergab sich insbesondere, daß der Schinken wegen schlechterer Qualität billiger verkauft war, aber das Wesen seiner Schlechtigkeit wurde nicht ermittelt. Erst nachträglich hat Tüngel[1]) aus den sehr sorgfältig geführten Akten den Beweis geführt, daß Erscheinungen und Verlauf der Krankheit genau mit dem übereinstimmten, was wir jetzt von der Trichinenkrankheit wissen.

Diese Fälle ließen sich leicht vermehren. Es genügt jedoch das Mitgetheilte, um den Beweis zu führen, daß die Erkrankungen schon vorhanden waren, ehe die Kenntniß von der Trichinenkrankheit vorhanden war, und daß das Neue an der Sache nicht die Krankheit, sondern die Kenntniß derselben ist. Möge daher Niemand mit so hinfälligen Gründen eine Gefahr zu verschleiern suchen, welche nur bei bewußtem Einblick in

[1]) C. Tüngel, Mein Archiv 1863. Bd. XXVIII. S. 391.

die Quellen der Störung zu vermeiden oder wenigstens im höchsten Maaße zu vermindern ist.

3) Welche Mittel gibt es gegen die Trichinen-Krankheit?

So wenig es in der Aufgabe dieses Schriftchens liegen mag, in das eigentlich technische Detail einzugehen, so will ich doch die so oft an mich gerichtete Frage nicht ganz unbeantwortet lassen: Ist die Trichinenkrankheit heilbar?

Die vorstehenden Bemerkungen lehren, daß die Einkapselung eine Art von Naturheilung ist. Denn mit der Kapselbildung hört die Wanderung der Thiere auf; sie liegen dann in ihrem Gefängniß und führen ein so schwaches Leben, daß sie ganz und gar unbemerkt bleiben können. Aber die ärztliche Kunst vermag zu diesem Ausgange nichts beizutragen. Er tritt ganz von selbst im natürlichen Ablaufe der Erscheinungen ein und er läßt sich kaum beschleunigen oder auch nur begünstigen. Lebt der Kranke noch, wenn die Kapseln eine gewisse Ausbildung erreicht haben, so werden ihn die Trichinen wahrscheinlich nicht mehr tödten.

Freilich wäre es sehr erwünscht, ein Mittel zu kennen, welches die Trichinen tödtet, ohne den Menschen zu tödten. Denkbar wäre es, daß man ein solches Mittel fände. Denn es ist bekannt, daß manche Stoffe auf einzelne Thiere giftig einwirken, welche anderen gar nicht schädlich sind. Allein jedenfalls ist dieß Mittel gegen Trichinen noch nicht gefunden. Man hat an Arsenik, Kupfer, Quecksilber, Phosphor, Kampher, Terpenthinöl, Benzin u. s. f. gedacht, ohne bis jetzt thatsächliche Erfolge damit erzielt zu haben. Nur das Kali picronitricum schien in einem Falle von Friedreich[1]) wirklichen Nutzen gebracht zu

[1]) Friedreich, Mein Archiv, Bd. XXV. S. 399.

haben. Aber Versuche von Fiedler[1]) und Mosler[2]) haben auch diese Hoffnung wieder zerstört.

Ich bemerke indeß, daß es thöricht wäre, jede Kunsteinwirkung damit aufgeben zu wollen. Es liegt gewiß nahe, bei der Kunstheilung zunächst an die Muskeltrichinen zu denken. Denn diese sind ja die eigentlich gefährlichen Gäste, und sie zu tödten, wäre der größte Gewinn. Aber am Ende sind doch auch die Darmtrichinen sehr gefährliche Thiere; sie erzeugen die junge Brut, welche einwandert, und von ihrer Zahl und von der Zeit ihrer Anwesenheit im Darm hängt die Zahl der Eindringlinge unmittelbar ab. Nichts sollte also dringlicher erscheinen, als die Mutterthiere, welche im Darm leben und immer neue Brut hervorbringen, zu entfernen. Werden sie sehr frühzeitig entfernt, so wird überhaupt keine Einwanderung von Brut in die Muskeln stattfinden; geschieht ihre Entfernung, nachdem die Einwanderung schon begonnen hat, so wird sie wenigstens unterbrochen werden, und die Gefahr wird nicht mehr steigen.

Die Entfernung der Mutterthiere kann nur durch Erbrechen oder Abführen nach unten geschehen. Erbrechen wird nur in den Fällen etwas nützen, wenn es bald nach dem Genuß des inficirten Fleisches eintritt, also zu einer Zeit, wo letzteres noch nicht den Magen verlassen hat. Dieß wird nur in den seltensten Fällen zutreffen, in denen die Anwesenheit von Trichinen in Fleisch, Schinken, Wurst oder dergl. frühzeitig bemerkt wird. Die Regel wird vielmehr das Abführen sein; daß auf diesem Wege eine Entfernung der Thiere erfolgen könne, ist sicher. Schon in meiner Mittheilung an die Pariser Akademie (1860) hatte ich erwähnt, daß von mehreren Kaninchen, welche gleichzeitig trichinisches Fleisch bekommen hatten, diejenigen, welche Durchfall bekamen, frei von Trichinen gefunden wurden. Dieß hat sich auch später, sowohl

[1]) Fiedler, Ebendaselbst. Bd. XXVI. S. 573.
[2]) Mosler, Ebendaselbst. Bd. XXVII. S. 421.

bei Thieren, als bei Menschen bestätigt, und es ergibt sich daraus die praktische Regel, in Fällen, wo wahrscheinlich oder sicher eine Infektion stattgefunden hat, zu **starken** Abführmitteln zu greifen. Möglicherweise wird man auch hier, wie es bei den Band- und Spulwürmern der Fall ist, bestimmte Stoffe kennen lernen, welche die Würmer betäuben, narkotisiren, und wird solche Stoffe vor den Abführmitteln nehmen lassen, um den Abgang der Würmer zu erleichtern.[1])

Allerdings wird dadurch denjenigen Kranken nicht geholfen, welche schon eine sehr zahlreiche Einwanderung erfahren haben. Aber gewiß ist es doch nicht gering anzuschlagen, daß man denjenigen nützen kann, bei denen die Einwanderung entweder überhaupt noch nicht stattgefunden, oder bei denen sie nur eine geringe Ausdehnung erreicht hat. Was die in den Muskeln angelangten Trichinen betrifft, so ist meine Hoffnung gering, daß man ein Mittel finden wird, sie zu tödten. Ist dieß doch noch nicht einmal für die Finnenwürmer gelungen, trotzdem, daß wir bestimmte und sichere Bandwurmmittel genug besitzen. Es erklärt sich dieß leicht, wenn man erwägt, daß alle Mittel, welche auf die Würmer wirken sollen, nur vom Blute des Menschen aus wirken können. Wenn Jemand ein Mittel einnimmt, so muß es zunächst vom Blute aufgenommen, durch dasselbe zu den Muskeln gebracht werden und nun in diese selbst eindringen. Jedes Mittel wird auf diesem langen Wege vom Magen bis zu den Muskeln sehr verdünnt und im ganzen Körper vertheilt, es gelangt daher zu allen einzelnen Muskeln nur in sehr kleinen und wahrscheinlich wirkungslosen Mengen. Sind aber die Thiere schon eingekapselt, so werden sie um so weniger von diesen kleinen Mengen betroffen

[1]) Nach den so eben veröffentlichten Versuchen von Fiedler (Archiv für Heilk. 1864. V. S. 21) waren freilich Abführmittel bei trichinisirten Katzen und Kaninchen erfolglos; doch können diese Versuche nicht von weiteren abschrecken.

werden, denn die Kapseln selbst setzen dem Eindringen von Stoffen erweislich einen großen Widerstand entgegen. Schon in meiner Mittheilung an die französische Akademie habe ich erwähnt, daß ich trichinisches Fleisch in eine Lösung von Chromsäure gethan hatte, um es zur mikroskopischen Untersuchung zu härten, und daß in dieser Lösung, welche so stark war, daß alle übrigen Theile geronnen und fest geworden waren, sich also sehr leicht in feinste Scheiben zerlegen ließen, die Trichinen sich noch lebendig erhalten hatten. Und dieß war ein Fall, wo die Einkapselung der Trichinen noch sehr wenig vorgeschritten war.

Man wird aus dieser Anführung die ganze Größe der Charlatanerie ersehen, welche es wagt, das öffentliche Urtheil über die Gefahr der Trichinenkrankheit unter Hinweis auf einzelne bestimmte Mittel zu verwirren. Es mag dem einzelnen Fabrikanten unbenommen sein, die Leichtgläubigkeit der Menge durch pomphafte Zeitungsartikel auszubeuten, aber es gehört eine seltene Gewissenlosigkeit, ja ein nicht geringer Grad sittlicher Verkommenheit dazu, wenn Leute, denen eine naturwissenschaftliche Vorbildung nicht abzusprechen ist, ihre industriellen Zwecke so weit ausdehnen, daß sie, aller Erfahrung und aller Theorie zuwider, ihre Fabrikate als zuverlässige Mittel gegen die Trichinen darstellen und dadurch Manchen verführen, sich einer schweren Gefahr leichtsinnig auszusetzen, die er sonst vermieden haben würde. Kein Schnaps und kein Liqueur gibt eine Sicherheit gegen die Erkrankung und noch weit weniger eine Wahrscheinlichkeit der Heilung.

Dagegen gibt es wohl Vorsichtsmaaßregeln, welche die Gefahr zum größten Theil beseitigen können, und diese wollen wir im Nachstehenden genauer besprechen, da sie nicht bloß den Behörden, sondern auch den einzelnen Hausvätern und Gewerbetreibenden bekannt sein sollen. Denn die Behörden allein können hier nicht helfen.

4) Welche Vorbeugungs-Maaßregeln gegen die Verbreitung der Trichinen sind nöthig?

In der geschichtlichen Einleitung habe ich diejenigen Thiere erwähnt (S. 5), bei welchen bis jetzt Trichinen gefunden sind. Man ersieht daraus leicht, daß es sich hier nur um fleischfressende (carnivore und omnivore) Thiere handelt. Allerdings ist der Maulwurf darunter aufgeführt, den sonderbarerweise noch mancher Landwirth für ein pflanzen-, namentlich wurzelfressendes Thier hält, aber seine große Bedeutung als Vernichter von Engerlingen, Regenwürmern, Schnecken, Mäusen und jungen Ratten hat der kürzlich verstorbene Gloger[1]) in einigen seiner verdienstlichen Schriften hinreichend auseinandergesetzt.

In der That liegt es auf der Hand, daß im gewöhnlichen Gange der Dinge Trichinen nur bei Fleischfressern vorkommen können. Denn wir haben ja gesehen, daß die Darmtrichinen lebendige Junge erzeugen, welche in das Fleisch einwandern und nur hier ihre weitere Entwickelung erlangen (S. 29), daß sie aber aus dem Fleische nicht anders herauskommen können, als indem das Fleisch wieder gefressen oder gegessen wird. Dieser regelmäßige Kreislauf vom Darm zum Fleisch und vom Fleisch wieder zum Darm ist aber nur möglich bei Fleischfressern.

Freilich gibt es zwei Ausnahmen davon.

Einmal sind die pflanzenfressenden Thiere nicht so absolut in der Wahl ihrer Nahrung, daß sie nicht gelegentlich auch einmal Fleisch zu sich nähmen. Wenn man einem Kaninchen, einem Rind, einer Taube kleine Fleischstückchen in den Mund bringt, so schluckt es sie herunter, und darauf beruht ja eben die Möglichkeit, bei ihnen Fütterungen mit trichinischem Fleisch vorzunehmen,

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[1]) Gloger, die nützlichsten Freunde der Land- und Forstwirthschaft unter den Thieren. Zur Belehrung für Landleute und Landschullehrer. Berlin 1859. S. 9. Kleine Ermahnung zum Schutze nützlicher Thiere, als naturgemäßer Abwehr von Ungezieferschäden und Mäusefraß. Berlin 1862. S. 7.

auf welche im Vorstehenden mehrfach hingewiesen ist. Es könnte daher durch irgend einen Zufall wohl geschehen, daß auch ohne künstliche Fütterung ein Pflanzenfresser einmal trichinisches Fleisch genösse, indeß kann ich zum Trost meiner Leser hinzufügen, daß bis jetzt wenigstens ein solcher Fall noch nie beobachtet ist.

Es ist aber auch noch ein anderer Weg denkbar, als der durch den Genuß von Fleisch, auf welchem eine Ansteckung erfolgen könnte. Schon *Leuckart*[1]) hat auf diese Möglichkeit hingewiesen. Wenn nämlich bei einem Thiere, welches trächtige Darmtrichinen besitzt, diese mit den Kothentleerungen abgehen, so könnte es sein, daß dieser Koth und damit natürlich auch die darin enthaltenen Trichinen von anderen Thieren gefressen würden. Gerade von den Schweinen ist es ja hinreichend bekannt, daß sie, und zwar besonders menschlichen, Koth häufig genug verzehren. Daß auf diese Art eine Uebertragung ohne eigentlichen Fleischgenuß erfolgen könne, ist klar, und obwohl diese Art der Uebertragung bis jetzt nicht sicher festgestellt ist, so ist es doch sehr wahrscheinlich, daß gerade bei Schweinen dieselbe öfter vorkomme und die Möglichkeit läßt sich nicht ableugnen, daß auch andere Thiere gelegentlich auf diesem Wege angesteckt werden mögen.

Von den Trichinen der Maulwürfe, der fleischfressenden Vögel, ja selbst der Katzen steht es, wie erwähnt, noch nicht ganz fest, ob sie mit denen der Schweine und des Menschen identisch sind. Auf alle Fälle kommen sie, wenn man von dem in großen Städten zuweilen geschehenden Genusse von Katzenfleisch absieht, nur insofern für die hier vorliegende Untersuchung in Betracht, als möglicherweise die Schweine durch ihre Vermittelung erkranken könnten. Jedoch liegen dafür bis jetzt keine bestimmten Anhaltspunkte vor, und es wäre nur bei ferneren Beobachtungen darauf Rücksicht zu nehmen, gleichwie es ein Gegenstand besonderer

[1]) *Leuckart* a. a. O. S. 50.

Aufmerksamkeit sein sollte, festzustellen, woher die Maulwürfe ihre Trichinen beziehen.

Ich betrachte also zunächst das als ausgemacht, daß *als verdächtig nur die fleischfressenden, die „unreinen" Thiere und unter ihnen als die verdächtigsten die Schweine anzusehen sind.* Ob auch das wilde Schwein der Ansteckung ausgesetzt ist, weiß man bis jetzt nicht. Dagegen können *die pflanzenfressenden Thiere als rein und unverdächtig* gelten, und wenn gerade in der neuesten Zeit das Gerücht verbreitet wird, daß manche der trichinischen Schweine auf Abdeckereien erzogen und mit Fleisch von getödteten oder gefallenen Thieren gefüttert seien, so ist dieß nicht bloß, wie ich mich durch besondere Nachfragen in Hettstädt u. a. m. überzeugt habe, thatsächlich unrichtig, sondern es ist auch theoretisch falsch, weil das auf Abdeckereien vorfindliche Fleisch gewöhnlich von Pflanzenfressern (Pferden, Rindvieh, Schaafen u. s. w.), also von „reinen" Thieren herstammt.

Die wesentliche Sorge der Behörden und der Einzelnen hat sich daher auf die Schweine zu lenken. Hier ergeben sich nun folgende Gesichtspunkte:

1) *Es muß der Ansteckung der Schweine durch Trichinen so viel als möglich vorgebeugt werden.*

Ich erwähne hier noch einmal, weil es mir so oft in Privatgesprächen vorgehalten ist, daß von einer *Entstehung* der Trichinen in den Schweinen oder wo sonst nicht die Rede sein kann. Trichinen werden gezeugt, wie Menschen, von Vater und Mutter; sie pflanzen sich fort in legitimer Erbfolge, und ihr Vorkommen in einem Thier setzt daher selbstverständlich die *Ansteckung* des letzteren von außen her und zwar *durch die Nahrung* voraus.

Es wird also vor allen Dingen nothwendig sein, die Nahrung der Schweine zu überwachen, und ihnen so viel als möglich die Gelegenheit zu entziehen, verdächtige thierische Stoffe zu genießen. Als solche haben wir aber einerseits trichinisches Fleisch, andererseits Darmabgänge von trichinischen Individuen, namentlich menschlichen Koth, anschuldigen müssen. **Reine Stallfütterung bei größter Reinlichkeit**, wie sie übrigens das Interesse der Viehzüchter selbst erfordern sollte, müßte die größte Sicherheit geben, obwohl natürlich zufällige Ansteckungen nicht unbedingt vermieden werden können. Ob die **Waldmast** vor allen Gefahren sichert, steht dahin; Erfahrungen fehlen, und die Thatsache, daß auch wilde Thiere Trichinen haben können, mindert wenigstens die theoretische Sicherheit.

Jedenfalls werden besonnene Landwirthe und Viehzüchter durch diese Bemerkungen auf einen wichtigen Gesichtspunkt aufmerksam werden. Ich füge noch hinzu, daß bis jetzt die meisten Epidemien von Trichinenkrankheit aus sächsischen Bezirken bekannt geworden sind, und daß gerade in mehreren derselben Stallfütterung die Regel ist. Hier würde also besonders eine skrupulöse Reinlichkeit zu empfehlen sein.

2) **Es muß eine sorgfältige Fleischschau vorgenommen werden.**

Nach dem früher Auseinandergesetzten gibt es kein sicheres Zeichen der Trichinenkrankheit bei Schweinen. Es bleibt also nichts übrig, als eine sorgfältige Untersuchung des Fleisches. Daß dazu nur in wenigen Fällen, nämlich in denen, wo die Trichinen eingekapselt und verkreidet sind, die Betrachtung mit bloßem Auge genügt, habe ich gezeigt; es bedarf meist einer **mikroskopischen Untersuchung**.

Wenn zu diesem Zwecke die besten Instrumente, wie immer, vorzuziehen sind, so sind sie doch nicht gerade nothwendig. Im Gegentheil genügen dazu schon Mikroskope mit mäßigen Vergrößerungen, wobei ich jedoch darauf aufmerksam mache, daß schlechte

Mikroskope, welche eine starke Vergrößerung prätendiren, in der Regel weniger brauchbar sind, als gute Instrumente mit sehr mäßiger Vergrößerung.

Auf meine Veranlassung hat der Optiker **Hänsch** in Berlin (Karlsstraße 8) kleine Mikroskope eigens zu diesem Zwecke eingerichtet. Dieselben geben eine 100 bis 180fache Vergrößerung und kosten nur 10 bis 12 Thlr. Für die Untersuchung empfehle ich, das Fleisch in der früher (S. 23) angegebenen Art zu präpariren und es zunächst mit schwächeren Vergrößerungen zu betrachten. Findet man darin etwas Verdächtiges, so stellt man diesen Punkt genau ein und nimmt nun die stärkere Vergrößerung, um ihn in seine Einzelheiten aufzulösen.

Ebenfalls sehr empfehlenswerth sind die einfachen Mikroskope (Simplex) des berühmten Optikers **Schiek** in Berlin (Marienstraße 1), welche nicht so starke Vergrößerung liefern, aber um so genauer gearbeitet sind. Sie kosten 20 Thlr.

Weniger günstig für die Untersuchung, dagegen überaus bequem für die Demonstration sind die **Rappard**'schen Instrumente (von **Engell** u. Co. in Wabern bei Bern), wie sie **Schäffer** und **Budenberg** in Buckau-Magdeburg zu 11⅓ Thlr. liefern. Diese Instrumente haben ihrer Einrichtung nach, die wieder durch den Zweck (die Demonstration) bedingt wird, ein mehr diffuses Licht, und weichere Gegenstände, welche man durch sie betrachtet, entbehren der scharfen Contouren, welche gerade für weniger geübte Beobachter höchst wichtig sind.

Für größere Ansprüche sind die gebräuchlichen Mikroskope zu 40—50 Thlr., wie sie **Hänsch**, **Schiek**, **Wappenhans** u. A. in Berlin, **Belthle** in Wetzlar, **Hartnack** in Paris u. A. liefern, zu empfehlen.

Es fragt sich nun, **wer** soll diese Untersuchungen vornehmen?

Darauf antworte ich: **In Städten sollte überall eine** amtliche **Fleischschau eingerichtet und durch Aerzte, Thierärzte oder sonstige Naturkundige vorgenommen werden.**

In großen Städten ließe sich das natürlich am einfachsten einrichten, wenn man **öffentliche Schlachthäuser** herstellte. Auch abgesehen von Trichinen läßt sich für diese vielerlei sagen, und mit Recht hat man an verschiedenen Orten, auch Deutschlands, sich schon zu ihrer Einrichtung entschlossen. Für die Städte wird damit eine nicht unwichtige Quelle der Verunreinigung der Gossen, Höfe, Häuser verschlossen. Hat man Schlachthäuser, so ist nichts einfacher, als darin Mikroskope aufzustellen, und kein Schweinefleisch früher zum Verkauf gelangen zu lassen, als bis ein amtlicher Schein über die Reinheit des betreffenden Thieres vorliegt. Der betreffende Aufsichtsbeamte wird von verschiedenen Muskeln desselben Thieres kleinere Theile untersuchen, was in Zeit von zehn Minuten ausgeführt sein kann, und danach seinen Vermerk auf den Schein aufzeichnen.

In kleineren Städten, wo man keine Schlachthäuser haben kann, wird dem betreffenden Aufsichtsbeamten in anderer Weise Gelegenheit gegeben werden müssen, seine Untersuchung vorzunehmen, und ich bezweifle nicht, daß das überall möglich ist. Schon jetzt haben die Metzger an verschiedenen Orten, z. B. in Stettin, Nordhausen, Verträge mit bestimmten Aerzten abgeschlossen, welche ihr Fleisch prüfen und die Reinheit desselben feststellen. Aber das genügt nicht, denn es handelt sich hier nicht bloß um das Privatinteresse der Metzger, sondern um **die öffentliche Gesundheitspflege**, und für diese hat die **Gemeinde**, unter Umständen der **Staat** einzutreten.

An die Städte schließen sich die größeren Marktflecken und Dörfer, die größeren Kranken- und sonstigen Anstalten, Schiffe u. dgl. Nichts ist leichter auszuführen, als daß eine geeignete Persönlichkeit, ein Arzt, ein Geistlicher, ein Lehrer, ein Schiffs-

kapitain u. s. w., in den nöthigen Manipulationen geübt wird. Auf größeren Gütern wird der Gutsherr selbst oder dessen Inspektor, Verwalter u. s. w. gewiß so viel Interesse haben, sich von der Reinheit des für die Leute und die Herrschaft in Gebrauch kommenden Fleisches zu überzeugen, und weder die Arbeit, noch der Preis des dazu nöthigen Instrumentes kann in irgend ein Verhältniß gestellt werden zu den Bürgschaften der Sicherheit, welche dadurch für Leib und Leben gewonnen werden.

Noch einmal weise ich darauf hin, daß es eine Thorheit ist, zu sagen, die Fälle der Erkrankung seien doch zu selten, um einen solchen Aufwand von Hülfsmitteln durch das ganze Land, ja durch die ganze Welt in Bewegung zu setzen. Was der Einzelne für sich thun will, das ist seine Sache, aber die Allgemeinheit hat die Aufgabe, Gefahren, in welche der Einzelne unbewußt und ohne sein Zuthun gerathen kann, möglichst abzuhalten und insbesondere denjenigen, welche Anderen Schaden bereiten können, ohne es zu beabsichtigen, beizustehen, und wo es nöthig ist, sie zu überwachen, damit sie ihre Thätigkeit wirklich zum Nutzen ihrer Mitbürger ausüben. Ein Metzger, der, wenn auch unabsichtlich, die Veranlassung wird, daß Hunderte von Menschen erkranken und Dutzende davon sterben, kann sich nicht beklagen, wenn er in ähnlicher Weise überwacht wird, wie ein Fabrikant, der mit gefährlichen Chemikalien arbeitet.

Am übelsten sind natürlich die kleineren Besitzer, zumal auf dem platten Lande, daran, welche sich nicht selbst Mikroskope halten können und welche auch Niemand zur Hand haben, der ihnen die Untersuchung macht. Sicherlich wird es einmal dahin kommen, daß ein jeder Lehrer auch ein kleines Mikroskop zu seiner Verfügung hat, aber darüber wird wohl noch einige Zeit hingehen. Bis dahin ist den kleinen Besitzern nur dadurch zu helfen, daß sie sich in der Bereitung ihrer Speisen möglichst vorsehen. — Diesen Punkt haben wir noch ausführlicher zu besprechen.

3) Alles Schweinefleisch muß in besonders sorgfältiger Weise zubereitet werden.

An nicht wenigen Orten herrscht die Gewohnheit, das Schweinefleisch roh, namentlich in geschabter Form, zu genießen. Ich sehe dabei ganz von den Metzgern und Köchinnen ab, bei denen dieß mehr gelegentlich vorkommt. Ich will auch nicht davon sprechen, daß zuweilen auf ärztliche Anordnung geschabtes Fleisch gegessen wird, da Aerzte dabei in der Regel nicht Schweinefleisch im Sinne haben. Aber an manchen Orten geschieht dieß gewohnheitsgemäß. So sind gerade in Burg nicht wenige Fälle von Erkrankungen und Todesfällen dadurch entstanden, daß zum Frühstück rohes, geschabtes Fleisch auf Brot gegessen wurde, Fälle, welche um so mehr charakteristisch sind, als zuweilen in derselben Familie einzelne Glieder frei blieben, welche von demselben Fleisch in gekochter oder gebratener Form gegessen hatten, von dem andere, welche schwer erkrankten, roh genossen hatten.

Es wird sich daher wohl empfehlen, **Schweinefleisch überhaupt niemals roh zu genießen.** Denn selbst eine genauere mikroskopische Untersuchung wird eine absolute Sicherheit nie gewähren können. Einzelne Trichinen können auch dabei übersehen werden, und wenngleich solche einzelnen nach dem Genusse keine besonders schweren Zufälle hervorbringen werden, so ist es doch ungleich sicherer, diese Gefahr überhaupt zu vermeiden. Wer das Bedürfniß hat, sei es aus medicinischen Gründen, sei es aus Liebhaberei, rohes Fleisch zu genießen, der mag sich doch an Rind- oder Hammelfleisch halten.

Allein auch die Zubereitung an sich gibt keine Sicherheit, wenn sie nicht sorgfältig geschieht. Beim Kochen, Braten, Rösten und Räuchern kann sehr leicht ein mehr oder weniger großer Theil des Fleisches in einem rohen oder nahezu rohen Zustande bleiben, und dann die gleiche Gefahr bringen.

Am größten ist diese Gefahr beim **Schinken**, namentlich seitdem die Schnell- oder Fix-Methoden der „Räucherung“ aufgekommen sind. Hierbei wird der Schinken in Wahrheit entweder gar nicht geräuchert, oder doch so kurz und schwach, daß der größte Theil desselben „frisch“ bleibt. Man bestreicht ihn mit Kreosot, Holzessig oder sonst einem brenzlichen Stoff und bringt ihn in den Handel. Enthielt er Trichinen, so bleiben diese nach allen diesen Behandlungen wenigstens innen lebendig.

Ganz anders war es in früherer Zeit. Damals schlachtete man in der Regel die Schweine im Herbst, hing dann die Schinken in die Räucherkammer oder den Schornstein, bewahrte sie bis zum nächsten Jahre auf und nahm sie nach einem halben Jahre oder noch später in Gebrauch. Nach einer solchen Behandlung sind die Trichinen todt und unschädlich. Aber freilich ist der Schinken dann trocken und hart, und er schmeckt weniger gut. Unsere Vorfahren sahen dieß als keinen Vorwurf an. Sie wußten, daß man von solchem Schinken auch weniger ißt; er sättigt mehr. Sie standen in dieser Beziehung auf demselben Standpunkte, wie noch heutigen Tages die Leute in den norwegischen Gebirgsthälern, die ihr Fleisch nicht räuchern, sondern an der Luft trocknen, und es dann auch erst nach einem halben oder ganzen Jahre genießen.

Solchen altmodischen Schinken bekommt man im Handel nicht mehr. Auch in Westfalen hat die Schnellräucherung Platz gegriffen. Das Bedürfniß des Handels räumt die Bestände schnell auf. Daher bietet der käufliche Schinken keine Sicherheit mehr. Wer seinen Schinken selbst verfertigt oder verfertigen läßt, hat es in der Hand, die Räucherung und Aufbewahrung lange genug fortzusetzen, um jede Gefahr zu überwinden, und daher ist namentlich auf dem Lande und in kleineren Städten bei vorsichtigen Leuten weniger zu besorgen. Wer aber den Schinken kauft, der hat nur zwei Möglichkeiten, sich zu sichern:

Entweder er untersucht den Schinken mikroskopisch oder läßt ihn untersuchen. Dazu reicht es aus, an verschiedenen Stellen einzelne Scheiben herauszuschneiden und diese zu prüfen.

Oder er läßt ihn kochen. Im Süden, schon in Süddeutschland, ißt man bekanntlich fast gar keinen rohen Schinken, dagegen sehr viel gekochten. Daraus erklärt es sich vielleicht, daß bis jetzt wenigstens so viel weniger Fälle von Trichinenerkrankungen von da bekannt geworden sind. Indeß fehlen sie doch nicht. Ich selbst habe in Würzburg ein Paar mal sehr zahlreiche, eingekapselte Trichinen beim Menschen gefunden, und in Tübingen, in Heidelberg sind wiederholt Fälle beobachtet.

Zunächst dem Schinken steht die **Wurst**, und zwar insbesondere die Fleisch- (Cervelat-) Wurst. Leber- und Blutwurst, wenn sie rein bereitet sind, sowie die hier und dort gebräuchliche Reis- und Grützwurst sollten davon ausgenommen sein. Indeß ist die Sicherheit eine geringe, wenn man nicht weiß, wie die Wurst zubereitet war. Oft genug wird namentlich Leber- und Blutwurst mit Fleisch gemengt, und die Erfahrung hat gelehrt, daß gerade durch solche Wurst und solches Wurstfleisch schwere Erkrankungen herbeigeführt sind (Dresden, Calbe, Burg). In Hettstädt war es namentlich sogenannte Magenwurst oder Schwartenmagen, in welcher zahlreiche Trichinen gefunden wurden.

Mit der Zubereitung der Wurst ist in der neueren Zeit eine ähnliche Veränderung vorgegangen, wie mit der Zubereitung des Schinkens. Früher kochte man, wie es freilich noch jetzt in vielen Familien geschieht, die Wurst stärker, um Wurstsuppe zu gewinnen. Die Bratwurst wurde stärker geröstet, die Rauchwurst länger geräuchert und länger aufbewahrt. Heute, zumal in den Städten, wo für den Verkauf gearbeitet wird, muß Alles schneller gehen und die Wurst muß „frischer“, saftiger, roher sein. So liebt es der Geschmack der Käufer. Es versteht sich daher von selbst, daß, je mehr die Wurstbereitung aus den Händen der Fa-

milie in die Hände des Gewerbetreibenden übergegangen ist, die Gefahr sich gemehrt hat, und vielleicht erklärt das, worüber sich so Viele wundern, etwas die größere Zunahme der Erkrankungen, wenn anders man eine solche zugestehen darf.

Immerhin konnte man auf eine solche Größe der Gefahr nicht vorbereitet sein. Nach einer Mittheilung des Dr. Rupprecht in Hettstädt bereitet man dort die Wurst so, daß das Fleisch mit Schwarten u. s. f. erst $1\frac{1}{2}$ bis 2 Stunden im Kessel gekocht wird; dann wird der Darm gefüllt und die nun fertige Wurst noch einmal $\frac{1}{2}$ bis $\frac{3}{4}$ Stunden im Kessel gekocht. Von einer solchen Wurst hatte man am Abend des 18. Oktober in einer Familie Stücke abgeschnitten und dieselben in einem Tiegel geschmort, bis das Fett ablief, und dann gegessen. Alle Glieder der Familie, fünf an der Zahl, erkrankten; ein kleiner Junge starb. Und doch soll nichts weiter von dem kranken Schweine genossen sein.

Es begreift sich nach dieser und ähnlichen Erfahrungen, daß ein großer Schrecken durch die Hettstädter Bevölkerung ging, und daß die Gemeindebehörde, später auch die Regierung zu Merseburg in öffentlichen Bekanntmachungen darauf hinwies, daß auch das Kochen nicht sichere. Ich werde sofort auf diese Frage zurückkommen, und bemerke nur, daß nach genauen Ermittelungen des Dr. W. **Müller** nach dem Kochen der Schwarten auch rohes Fleischfüllsel mit eingestopft und die so bereitete Wurst zwar noch einer warmen Brühe, aber keiner Siedhitze mehr ausgesetzt zu werden pflegt. Immerhin werden diese Mittheilungen genügen, um das Bedenkliche des Genusses von Wurst unbekannter Zubereitung, und namentlich frischerer Wurst zu zeigen, und auch hier wirft sich, wie bei dem Schinken, die Frage auf, ob nicht das sogenannte **Wurstgift**, wie das Schinkengift, wenigstens zum Theil gleichfalls auf Trichinen zurückzuführen ist. Namentlich in Schwaben sind seit Jahren Fälle von Wurstvergiftungen vorgekommen, wobei die chemische Analyse nichts mit Sicherheit herauszubringen im Stande war.

Ich komme endlich zum Kochen und Braten. Es ist ganz sicher, daß eine Trichine, die der wirklichen Siedhitze (80° R.) ausgesetzt wird, unzweifelhaft stirbt, ja, daß dieß schon eintritt[1]) bei einer Temperatur, bei welcher das Eiweiß gerinnt (50 bis 60° R.). Aber eben so sicher ist es, daß sehr häufig beim Kochen und Braten diese Höhe kaum erreicht wird, und daß, wenn sie erreicht wird, doch nicht das ganze Fleisch daran Antheil nimmt. Dieß ist namentlich dann nicht der Fall, wenn große Stücke im Zusammenhang gekocht oder gebraten werden. Man sieht es ja diesen Stücken beim Durchschneiden an, daß sie noch halb oder ganz roh sind. Das Blut und Eiweiß sind nicht geronnen, wie es durch Siedhitze geschieht; die Theile sind noch weich, frisch und roth. Noch mehr gilt dieß von gewissen Arten von Cotelettes. Hier kann kein Zweifel darüber sein, daß die Trichinen von einer tödtenden Temperatur im Innern des Fleisches nicht erreicht werden, und daß daher die Gefahr durch solches Kochen und Braten nicht beseitigt ist.

Ueber diese Verhältnisse besitzen wir direkte Versuche. — Küchenmeister[2]) fand, daß große Stücke Wellfleisch, die unzerschnitten in den Kessel gelegt waren, nach nur halbstündigem Kochen außen eine Temperatur von 48° R., innen von 44° hatten; nach mehr als halbstündigem Kochen nahmen sie außen eine Temperatur von 62 bis 64°, und wenn sie mehrfach durchschnitten in den Kessel gelegt worden, nach einstündigem Kochen innen eine Temperatur von 59 bis 60° an. Bratwurst und Cotelettes erreichten 50°, Frankfurter Wurst 51°, Schweinebraten, der innen noch blutig war, 52° R. Indeß gelten diese Zahlen natürlich

[1]) Fiedler, Archiv für Heilkunde. Jahrg. V. S. 27.
[2]) Küchenmeister, Zeitschrift II. S. 314.

nicht für alle Fälle, und es wird oft genug vorkommen, daß die Temperatur des Fleisches oder der Wurst mehrere Grade unter dieser Temperatur bleibt. Fiedler fand aber, daß Trichinen eine Temperatur von 30 bis 40° R. sehr wohl vertragen, daß sie auch bei 50 bis 52° R. nicht sofort sterben, obwohl sie sich dann nicht mehr lange zu erhalten vermögen.

Es folgt also aus dieser Zusammenstellung, daß das gewöhnliche Sieden von Brat- und Frankfurter Wurst, sowie die Zubereitung von Cotelettes und blutigem Braten eben nur an die Temperatur heranreicht, wo die Trichinen sterben.

Ich schließe mit den Ergebnissen der Versuche, welche Küchenmeister in Gemeinschaft mit Haubner und Leisering[1]) anstellte:

1) Die Trichinen werden getödtet durch längeres Einsalzen des Fleisches und durch 24stündige heiße Räucherung der Würste.
2) Sie werden aber nicht getödtet durch eine dreitägige kalte Rauch-Räucherung, und es scheint auch, daß das Kochen des Fleisches zum Wellfleisch sie nicht mit aller Sicherheit tödtet.
3) Ein längeres Aufbewahren kalt geräucherter Wurst scheint das Leben der Trichinen zu zerstören.

Möge nun Jedermann überlegen, wie weit das Mitgetheilte für ihn bestimmend sein soll. Meine Aufgabe war, nicht sowohl Furcht zu verbreiten und die Bevölkerung noch mehr aufzuregen, als sie es schon gegenwärtig ist, als vielmehr die Wege zu bezeichnen, wie sie sich vor der unzweifelhaften Gefahr zu schützen

[1]) Helminthologische Versuche. S. 8.

vermag. Denn es handelt sich hier um Verhältnisse, gegen welche die Polizei allein nicht ankämpfen kann, sondern gegen welche auch der Einzelne versuchen muß, sich zu schützen. Um das aber zu können, muß er eine genaue Einsicht haben in die Einzelnheit der Verhältnisse, und es scheint mir, trotz der vielfachen, schon verbreiteten Mittheilungen über dieselben, daß nur eine zusammenhängende Darstellung allen Zweifeln zu begegnen im Stande sei. Sollte dies gelungen sein, so habe ich meinen Zweck erreicht. Denn das ist ja eben der schöne Beruf der Wissenschaft, daß sie die Wunden, die sie schlägt, auch heilt. —

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Militär - chirurgische Fragmente.

Von

Dr. E. Gurlt,
a. o. Professor der Chirurgie an der Königl. Universität zu Berlin.

1. Ueber einige neue Transportmittel für Schwerverwundete.
2. Die Geschosse der preussischen und dänischen Feuergewehre.
3. Zur Statistik der Kriegswunden.
4. Ueber Granat-Verwundungen.

(Separat-Abdruck aus der Berliner Klinischen Wochenschrift. 1864.)

Berlin, 1864.
Bei August Hirschwald

Ein sechswöchentlicher Aufenthalt auf dem Kriegsschauplatze im Sundewitt, von Mitte März bis nach Erstürmung der Düppeler Schanzen, gab mir zwar Gelegenheit, des Neuen Manches und des Schrecklichen Viel aus nächster Nähe zu sehen, allein die Kürze der Beobachtungsfrist gestattete, bei den zahlreich vorgekommenen Verletzungen, nur in den tödtlich endigenden Fällen ein Verfolgen des Verlaufes derselben von Anfang bis zu Ende. Ich bin daher nicht im Stande, durch Krankengeschichten erläuterte Schilderungen bestimmter Arten von Verwundungen zu geben, sondern das Wenige, was ich zur Pathologie der Kriegswunden beibringen kann, stützt sich nur auf im Allgemeinen empfangene Eindrücke. Dagegen vermag ich einzelnes Neue in Betreff verbesserter Transportmittel für Verwundete anzuführen, ferner die zur Anwendung gekommenen Geschosse näher zu beschreiben, endlich auch einen Beitrag zur Statistik der Kriegswunden zu geben, und auf diese Weise vielleicht für spätere medicinische Beschreiber des Feldzuges von 1864 einige kleine Vorarbeiten zu liefern.

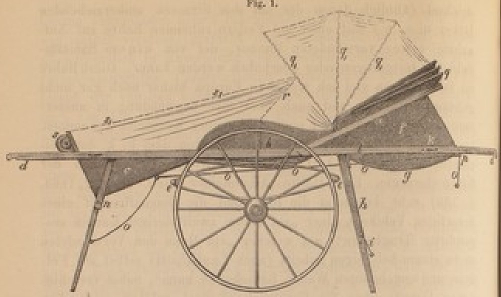
I. Ueber einige neue Transportmittel für Schwerverwundete.

Die Transportmittel, welche zur Fortschaffung Schwerverwundeter, theils vom Schlachtfelde nach den Verbandplätzen, theils von diesen nach den zunächst gelegenen Hospitälern zu benutzen sind, bestehen bekanntlich in Bahren und in Wagen; erstere seit undenklichen Zeiten in Gebrauch, letztere unter die Zahl der Kriegsfuhrwerke der verschiedenen Armeen erst in den letzten Jahrzehnten dieses Jahrhunderts aufgenommen. Wie sich von selbst versteht, erreicht das Fortschaffen auf den bisher ausschliesslich in Anwendung gekommenen, bekanntlich in sehr verschiedenartigen Constructionen vorhandenen Tragebahren (wenn wir von den neuerdings in unwirthlichen Ländern, besonders von den Franzosen, vielfach gebrauchten Maulthier-Sänften oder Cacolets absehen) sehr bald seine Grenze, indem über einen gewissen Raum und über eine gewisse Zeit hinaus das Tragen eines Verwundeten durch Menschenkräfte allein nur dann möglich ist, wenn eine grosse Zahl von Ablösungs-Mannschaften zur Hand ist. Für gewöhnlich aber, in Schlachten und Gefechten, ist ein solcher Ueberfluss an Mannschaft nicht vorhanden, im Gegentheil die Zahl der Sanitäts-Soldaten oder Krankenträger in allen Armeen eine so kärglich bemessene, dass auf jede Bahre höchstens, und im günstigsten Falle, 4 Träger gerechnet werden können, die, wenn sie, wie dies gewöhnlich der Fall ist, zu Zweien tragen, sich von Zeit zu Zeit ablösen müssen. Trotzdem aber erschöpft das Tragen schwerer Männer, wie die verwundeten Krieger in der Regel sind, die Kräfte der Träger sehr zeitig, selbst wenn die Strecken, auf welchen der Transport stattfinden soll, also etwa bis zu den nächsten Verbandplätzen hin, zwar nicht sehr gross, aber wegen der Menge der vorhandenen Verwundeten sehr oft zu passiren sind. Es hat sich in Folge dessen, namentlich in der neuesten Zeit, das Bedürfniss fühlbar gemacht, Transportmittel zu besitzen, welche leichter zu handhaben sind, als die nicht überall hinzuschaffenden Wagen, ferner zu ihrer Fortbewegung keiner Zugthiere, sondern nur eines oder höchstens zweier Menschen bedürfen, die ihrerseits bei der Fortbewegung des Vehikels nur wenig ermüden. Dieses lange Zeit unerfüllt gebliebene Problem ist erst durch die in neuester Zeit erfolgte Construction fahrbarer Bahren in so befriedigender Weise gelöst worden, dass dieselben als ein entschiedener, in dem Transportwesen gemachter Fortschritt zu bezeichnen sind. So weit meine Kenntniss darüber reicht, sind derartige Bahren zuerst in England erbaut worden; wenigstens habe ich bei einem Besuche des Arsenales zu Woolwich im October 1860, in dem Modellsaale desselben, zuerst eine solche gesehen, wie sie für die chinesische Expedition angefertigt worden waren, und in meinem „Beitrag zur Kenntniss des englischen Militär-Medicinal-Wesens“ (Preussische Militärärztliche Zeitung 1861, Nr. 8—12; Separat-Abdruck S. 49, Note) folgendermassen kurz beschrieben: „kleine zweiräderige Schubkarren mit Gabel-

deichsel (ähnlich denen der auf den Strassen umherziehenden Höker u. s. w.) mit einer auf Federn ruhenden Bahre zur Aufnahme eines verwundeten Mannes, der von einem Sanitäts-Soldaten fortgezogen oder geschoben werden kann“. Diese Bahre ist indessen, so viel ich weiss, in Europa bisher noch gar nicht gebraucht worden, und auch über ihre Verwendung in aussereuropäischen Ländern ist nichts zu meiner Kenntniss gekommen. Demnächst ist in der allerneuesten Zeit von dem k. k. österreichischen Regiments-Arzt Dr. J. Neudörfer (Handbuch der Kriegschirurgie. Erste Hälfte. Allgemeiner Theil. Leipzig, 1864, S. 132) sehr bestimmt die Idee und die Beschaffenheit eines derartigen Vehikels, einer „auf einem zweiräderigen Karren suspendirten Tragbahre“, auf welcher „ein Mann den Verwundeten so in einem beliebigen Schritt (auch Laufschritt) selbst auf Feldern und ungebahnten Wegen fortschaffen kann“, nebst verschiedenen Details über die Construction eines solchen angegeben worden. Indessen erst die Munificenz der Genossenschaft der preussischen Johanniter-Ritter, welche sich nicht nur die Errichtung von Hospitälern auf dem Kriegsschauplatze, sondern auch die Beschaffung von Transportmitteln für Schwerverwundete vom Schlachtfelde nach den Lazarethen zur Aufgabe gemacht hatten, gab dem Hof-Wagen-Fabrikanten Herrn Jos. Neuss zu Berlin, an den man sich wegen Erbauung der erforderlichen Vehikel gewendet hatte, Gelegenheit zur Construction einiger sehr zweckmässiger, im Nachstehenden näher zu beschreibender Transportmittel, unter denen sich auch fahrbare Bahren befinden. Dabei will ich nicht unerwähnt lassen, dass die sämmtlichen für den Johanniter-Orden gelieferten, verschiedenen Transportmittel, bestehend in 2 Transportwagen, 4 zweiräderigen und einer Anzahl von Handbahren innerhalb des überaus kurzen Zeitraumes von 13 Tagen aus den Werkstätten des Herrn Neuss, dem ich übrigens die Zeichnungen zu den nachstehenden Holzschnitten verdanke, hervorgegangen sind.

Was die Neuss'sche zweiräderige Bahre (vgl. Fig. 1., einfache, nicht perspektivische Seiten-Ansicht, in $\frac{1}{24}$ der natürlichen Grösse, so dass $\frac{1}{2}$ Zoll = 1 Fuss in der Wirklichkeit ist), zur Lagerung eines Verletzten in der Rückenlage, bei ganz stumpfwinkeliger Beugung der Hüft- und Kniegelenke, betrifft, so besteht dieselbe aus Hickory-Holz und Segeltuch, und sind die Räder derselben nach einem eigenen System construirt, welches eine besondere Leichtigkeit erlaubt. Es ist an derselben ein Kopf- und Rücken- (a), ein Becken- und Oberschenkel- (b)

Fig. 1.



und ein Unterschenkeltheil (c) zu unterscheiden, welche die beiden, an ihren vier Enden mit Handhaben (d,d) versehenen Seitenstangen der auf einer Druckfeder (e,e) jederseits ruhenden Bahre untereinander verbinden, während die Federn auf einer durch die zwei Räder unterstützten eisernen Achse stehen. Der Kopf- und Rückentheil (a) besitzt zwei hölzerne Seitenwände (f), welche zwischen sich, unter dem aus Segeltuch bestehenden und mit einem Kopfpolster versehenen Lager des Patienten, einen von hinten her zugänglichen, durch eine anzuknöpfende Klappe aus Segeltuch verschliessbaren Raum zwischen sich lassen, dessen ebenfalls aus Segeltuch bestehenden Grund man im ausgebauchten Zustande (bei g) sieht, ein Raum, der zur Aufnahme von Gepäck, eines Tornisters, oder von Verbandzeug, Labemitteln u. s. w. zu benutzen ist. Der Becken- und Oberschenkeltheil (b) der Bahre, dessen gleichfalls aus Segeltuch bestehender Grund im ausgebauchten Zustande in der Höhe der Feder (e) sichtbar ist, hat leichte, mit Segeltuch überspannte Seitenwandungen (bei b), an welchen sich beiderseits ein kleines Polster für die Ellenbogen befindet. Der Unterschenkeltheil (c) endlich besteht ganz aus Holz, sowohl in seinen Seitenwänden, als in seinem Grunde, auf welchem, in der Höhe der Fersen, nebeneinander zwei Löcher zur Aufnahme der Stiefelabsätze und Sporen des Verwundeten angebracht sind. Die Bahre kann, wenn sie nicht durch Fahren fortbewegt wird, mittelst zweier Paare von Füssen, deren jedes durch Querleisten untereinander verbunden ist, unterstützt werden. Die hinteren Füsse (h), welche

in Gemeinschaft mit den Rädern beim Stehen der Bahre das Gleichgewicht derselben fast allein schon erhalten, lassen sich mittelst eines Charnieres (l) nach hinten und oben hinaufschlagen und an einem (bei k) befindlichen Haken mit einem Riemen und einer Oese (i) befestigen; die Vorderfüsse, welche kürzer als die Hinterfüsse sind, indem sie mit einer den Unterschenkeltheil (c) umfassenden Eisenstange (n) durch ein Charnier verbunden sind, sind mit Hülfe eines fast unter der ganzen Länge der Bahre fortlaufenden Riemens (o,o,o,o) durch den hinter der Bahre hergehenden, dieselbe schiebenden Mann leicht nach hinten und oben zu ziehen, und durch eine kleine (bei p) angebrachte Sperrvorrichtung festzustellen. Der Kopf- und Rückentheil (a) ist endlich mit einem aus Segeltuch bestehenden (in der Zeichnung zurückgeschlagenen) Verdeck (q) versehen, welches gegen Sonne oder Regen hinaufgeschlagen werden kann, wie die Punktirung in der Zeichnung (q,q,q,) es andeutet; es wird dann dasselbe durch einen Riemen (r) mittelst Haken und Oese an der Seitenwand des Becken- und Oberschenkeltheiles (b) festgestellt Zur Bedeckung des übrigen Körpers befindet sich am Fussende, zusammengerollt (s) und mit zwei Riemen festgehalten, eine Decke von Segeltuch, welche hinaufgeschlagen (s,s,) und an dem Verdeck befestigt werden kann, so dass dann der auf der Bahre liegende Patient von allen Seiten her geschützt ist.

Fragt man nach den Leistungen dieser fahrbaren Bahre, so kann ich aus eigener Anschauung die Vorzüglichkeit derselben bestätigen. — Die Umstände, unter welchen die gedachten Bahren, welche, nebst den übrigen Transportmitteln des Johanniter-Ordens, sich bei dem Kriegshospitale des letzteren zu Nübel befanden, vor und nach der Erstürmung der Düppeler Schanzen zur Anwendung kamen, waren allerdings für fahrbare Transportmittel ungewöhnlich günstige, indem für den Rück-Transport von den Gefechts- nach den Verbandplätzen oder den im Rücken gelegenen nächsten Hospitälern grösstentheils die Sonderburger Chaussee oder gut gebahnte Wege benutzt werden konnten. Allein ich habe auch gesehen, dass die gedachten Bahren sich auf weniger ebenem Terrain, auf Ackerboden u. s. w. sehr gut fortbewegen liessen; selbst Hindernisse sehr bedeutender Art, welche von einem Wagen niemals passirt werden können, wie Gräben und Knicks, sind für diese zweiräderigen Bahren dadurch leicht zu überwinden, dass, sobald nur zwei Männer sich bei jeder derselben befinden, sie, was bei ihrer Leichtigkeit (das Gewicht beträgt bei der neuesten, sehr soliden Construction des

Herrn Neuss nur gegen 95 Pfund) ohne Schwierigkeit möglich ist, über die Hindernisse, wie gewöhnliche Handbahren, und ohne Rücksicht auf die Räder hinweggehoben werden. Ausserdem können auf ungewöhnlich unebenem Boden starke Schwankungen und Stösse von dem auf der Bahre liegenden Verwundeten durch eine aufmerksame Bedienungsmannschaft dadurch abgehalten werden, dass, sobald die Bahre über erhebliche Vorsprünge fort- oder durch beträchtliche Löcher hindurch passiren muss, durch Abheben eines oder beider Räder vom Boden eine jede unsanfte Bewegung des Vehikels mit Leichtigkeit verhütet wird. Auf ebenen Wegen aber ist ein einziger Mann leicht im Stande, das Fahrzeug auch weite Strecken ohne Ermüdung fortzubewegen, und zwar abwechselnd durch Ziehen und durch Schieben, je nachdem er sich an dem vorderen oder hinteren Theile der Bahre befindet. Auch auf dem Marsche werden die Bahren von den Mannschaften entweder gezogen oder geschoben, und können dabei, zu grosser Erleichterung der letzteren, für die Fortschaffung des Gepäckes derselben, wie ich dies selbst gesehen habe, benutzt werden; oder sie lassen sich zu zweien neben- oder zu noch mehreren hintereinander an vorhandene Kranken-Transport- oder andere Wagen anhängen und so weiterbefördern, oder endlich auch, nach Abnahme der Räder, auf Wagen ohne Schwierigkeit verpacken.

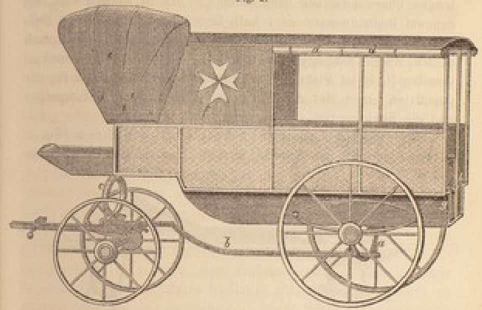
Diese Vorzüge der fahrbaren Bahren sind denn auch den Militär-Behörden nicht entgangen, und hat das Königl. Kriegs-Ministerium deren 6 anfertigen lassen und damit die erst zur Zeit der Erstürmung der Düppeler Schanzen mobil gemachte und nach Jütland dirigirte Krankenträger-Compagnie des Garde-Corps ausgerüstet. Ebenso sind, nach Mittheilungen des Hrn. Neuss, von verschiedenen anderen Staaten, namentlich Russland, Bestellungen derselben gemacht und auch anderweitig Zeichnungen und Modelle verlangt worden.

Wir glauben in der eben beschriebenen fahrbaren Bahre ein allen Anforderungen entsprechendes Transportmittel gefunden zu haben, das für die Zukunft wahrscheinlich eine grosse Rolle zu spielen bestimmt ist.

Die in neuerer Zeit bei den verschiedenen Armeen eingeführten verbesserten Transportwagen für die in ganz oder halb liegender Stellung zu befördernden Schwerverwundeten sind fast alle nach dem Principe construirt, dass in den von hinten her allein zugänglichen, omnibusartigen Wagen zwei auf Bahren liegende Verwundete, mit dem Kopfe oder den Füssen voran,

mit Leichtigkeit geschoben werden können, während der sonst für den Kutscher bestimmte Sitz des gewöhnlich vom Sattel aus gelenkten zwei- oder vierspännigen Fahrzeuges zur Aufnahme von mehreren sitzenden Leichtverwundeten bestimmt ist. Ausserdem muss ein solcher Wagen noch Räumlichkeiten zur Fortschaffung der Waffen, des Gepäckes der Verwundeten und von Verband- und Labemitteln u. s. w. enthalten*). Diese Grund-Principien sind auch bei dem sogleich näher zu beschreibenden, von Hrn. Neuss für den Johanniter-Orden neu construirten Transportwagen befolgt worden, jedoch mit einigen sehr zweckmässigen Modificationen, die wir näher angeben werden.

Fig. 2.



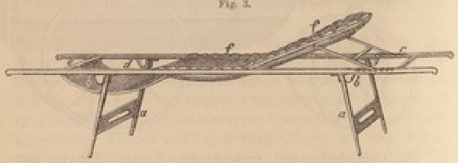
Der vierräderige und zweispännige Wagen (Fig. 2, perspectivische Seitenansicht), der nur ungefähr 6 Centner schwer ist, besteht aus einem Wagenkasten mit unterlaufenden Vorderrädern und eisernen Achsen, von denen die hintere (a) gebogen ist; auf denselben liegt ein Langbaum (b), und auf der Hinterachse zwei der Länge nach, auf der Vorderachse eine der Quere nach stehende Druckfeder (c). Der Wagenkasten hat sehr leichte Wandungen und in seinem oberen Theile nur wasserdichte Vor-

*) Näheres über die Kranken-Transportwagen verschiedener Armeen findet sich in meiner Brochüre: „Ueber den Transport Schwerverwundeter und Kranker im Kriege, nebst Vorschlägen über die Benutzung der Eisenbahnen dabei." Berlin 1860. S. 8 ff.

hänge von Segeltuch, welche hinaufzuschlagen und mit Riemen zu befestigen sind (d, d), ebenso wie das Vorderverdeck (e), und die Wandungen des mit dem weissen Johanniter-Kreuze bemalten, zur Aufnahme von Gepäck, Verbandgegenständen, Erfrischungen u. s. w. disponiblen Raumes (f) aus dem gleichen Stoffe bestehen. In dem Wagen befindet sich eine nicht ganz bis zur halben Höhe reichende Längsscheidewand (k), an welcher beiderseits, ebenso wie an den Seitenwandungen des in gleicher Höhe winkelig einspringenden Wagenkastens (g), einige Fuss über dessen Fussboden, horizontale, bankartige Holzbahnen (h, h) angebracht sind, auf welchen zwei der nachstehend beschriebenen und abgebildeten Bahren (Fig. 3), nachdem die langen Füsse derselben nach unten geschlagen worden sind, mit den auf ihnen in ganz oder halb liegender oder sitzender Stellung befindlichen Verwundeten, mit deren Füssen voran, sanft in den Wagen hineingeschoben werden können. Auf dem Vordersitze (i, i) ist Platz für wenigstens 3 Leichtverwundete; die punctirten Linien der Abbildung (bei i, i) deuten das Sitzpolster und die Sitzlehne an.

Die zwei für den Wagen bestimmten Bahren (Fig. 3, perspectivische Seiten-Ansicht) sind aus Eschenholz, bestehen aus

Fig. 3.



einem Rahmen, dessen mit vier Handgriffen versehene Seitenstangen durch vier Querhölzer unter einander verbunden sind. Die Bahre ruht auf 2 Paar, mit einander in Verbindung stehenden, 18½ Zoll hohen Füssen (a, a), welche mit Charnieren unter den Grund der Bahre geschlagen werden, sobald letztere in den Wagen geschoben wird, und dann nur auf den kleinen, etwas über 5 Zoll hohen, vier Füssen (b, b), welche sich dicht neben den langen Füssen befinden, steht. Die Bahre besitzt ausserdem einen auf zwei Zahnleisten (c) stellbaren Kopf- und Rückentheil, welcher das Einnehmen der vollständig sitzenden Stellung möglich macht. Der Grund oder Boden des Rahmens der Bahre besteht aus Segeltuch, welches an dem für die Lagerung der

Beine bestimmten Theile der Bahre (d) lose, d. h. auf den Seiten unbefestigt ist, wodurch beim Nachlassen der am vorderen Ende des Rahmens, nebst einem Sperrrade, befindlichen Rolle (e), auf welche der Segeltuchboden aufgerollt ist, eine solche Senkung des letzteren bewirkt werden kann, dass der Patient, bei gleichzeitig steil gestellter Rückenlehne, eine ganz sitzende Stellung einzunehmen im Stande ist. Das oberste Ende des Kopftheiles, so wie die beiden Langseiten des Rahmens (f, f) sind gepolstert und mit amerikanischem Leder überzogen.

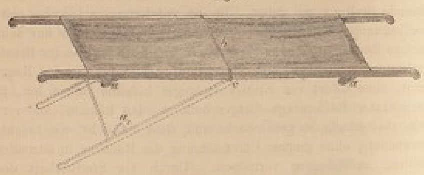
Die Vorzüge, welche dieser Transportwagen, neben grosser Leichtigkeit und Beweglichkeit, bei gehöriger Solidität, besitzt, bestehen darin, dass der Raum bei ihm sehr gut benutzt, und dass es möglich ist, den in ihm befindlichen Schwerverwundeten nach Erfordern ausser der liegenden auch eine halb oder ganz sitzende Stellung zu geben. Es ist auf Letzteres bei den seither bekannten Constructionen entweder gar keine, oder nur sehr geringe Rücksicht genommen worden, und doch ist dies für Brustverletzte von der grössten Bedeutung, da solche in der Regel nicht, ohne sofort von Erstickungsangst befallen zu werden, in horizontaler Rückenlage fortgeschafft werden können, andererseits aber häufig so geschwächt sind, dass sie nicht, wie Leichtverwundete, ohne genaue Unterstützung des Rückens in sitzender Stellung auszudauern vermögen. Durch die Stellbarkeit des Kopf- und Rückentheiles der Bahre, durch die gleichzeitig mögliche Senkung des Unterschenkeltheiles derselben, und den in dem Wagen, unterhalb der beiden bankartigen Holzbahnen vorhandenen Raum ist es möglich, dem Patienten eine bequem sitzende und dabei gut unterstützte Stellung, mit gebeugten Knieen, zu geben, während bekanntlich das Sitzen mit ganz gestreckten Beinen auf die Dauer sehr ermüdend ist. Bei den für den Wagen bestimmten Bahren sind ausserdem, wenn sie ausserhalb des Wagens auf ihre hohen Füsse gestellt werden, alle mit den auf ihnen liegenden Verwundeten vorzunehmenden Manipulationen, wie das Verbinden u. s. w., sehr viel leichter, als wenn, wie dies bei allen übrigen mir bekannten Transportwagen der Fall ist, die zu denselben gehörigen Bahren auf ganz niedrigen Füssen oder Rollen stehen, und demnach der auf ihnen befindliche Verwundete beinahe in gleicher Höhe mit dem Erdboden sich befindet. Endlich lassen sich an jeden der Transportwagen wenigstens zwei der oben beschriebenen fahrbaren Bahren anhängen, so dass auf gebahnten Wegen durch zwei Pferde, und mit Hülfe von zwei, die Bahren überwachenden Männern, mit einem

Male auf einem Wagen und seinen Anhängseln, wie ich dies behufs der Dislocirung Verwundeter wiederholt ausführen gesehen habe, 4 Schwer- und 3 Leichtverwundete befördert werden können.

Abbildungen des Neuss'schen Transportwagens und der fahrbaren Bahren, in verschiedenen, die Gebrauchsweise derselben veranschaulichenden Stellungen, finden sich auch in der Leipziger Illustrirten Zeitung, 1864, Nr. 1090, S. 352.

Endlich erwähne ich noch eine ebenfalls von Hrn. Neuss construirte, sich durch ihre Leichtigkeit (etwa 17 Pfund) und den geringen Raum, welchen sie, zummengeschlagen, einnimmt, auszeichnende Bahre, die er mit dem Namen Gefechts-Trage bezeichnet. Dieselbe (Fig. 4) besteht aus einem leichten, mit

Fig. 4.



Segeltuch überspannten Gerippe, besitzt 4 kleine, durch Charniere hinaufzuklappende Füsse (a, a), und lässt sich in ihrer Mitte der Quere nach (bei b) mit Hülfe von Charnieren (c) zusammenschlagen, wie der punctirte Theil der Zeichnung andeutet. Sie kann in Folge dessen in diesem Zustande von einem einzigen Menschen mit Leichtigkeit fortgeschafft werden, indem er sie entweder unter einen Arm, oder mit Hülfe eines Strickes oder Riemens auf den Rücken nimmt. Es dürfte diese Trage sich besonders für den Belagerungskrieg eignen, um Verwundete aus Laufgräben und Minen herauszubefördern, und in der That hat dieselbe auch bereits bei der Belagerung der Düppeler Schanzen eine sehr nützliche Verwendung in den Laufgräben und Parallelen gefunden.

2. Die Geschosse der preussischen und dänischen Feuergewehre.

Eine nähere Betrachtung der in dem Feldzuge des Jahres 1864 benutzten Projectile ist um so mehr gerechtfertigt, als der-

selbe zum ersten Male in Europa durchweg und auf beiden Seiten mit gezogenen Gewehren geführt worden ist, da noch im italienischen Feldzuge des Jahres 1859 ein Theil der französischen und piemontesischen Infanterie mit glatten Percussionsgewehren versehen war. Die durch die gedachten Präcisionswaffen herbeigeführten Verwundungen waren denn auch im gegenwärtigen Kriege, sowohl der Zahl als der Beschaffenheit nach, von derjenigen grossen Bedeutung, wie man sie erst in den Kriegen der allerneuesten Zeit zu beobachten Gelegenheit gehabt hat. Vergleicht man bloss, ganz abgesehen von der unendlich viel grösseren Treff- und Tragfähigkeit der jetzigen, auch bei der Infanterie fast aller Armeen eingeführten gezogenen Gewehre, die älteren sphärischen Geschosse mit den heutigen cylindro-konischen, oder sonst wie gestalteten, so fällt zunächst das viel beträchtlichere Volumen und Gewicht der neuen Geschosse in das Auge, und es ist schon hieraus ersichtlich, dass diese letzteren, die überdem eine viel grössere Propulsivkraft besitzen, als die alten, in der Regel aus glatten Gewehren geschossenen Kugeln, wenn sie einen Körpertheil nicht, wie dies normaler Weise der Fall sein soll, zuerst mit ihrer Spitze, sondern mit der Seite treffen, oder wenn sie auf irgend einem festen Körper, auf den sie aufschlagen, sei es einem Stücke der Armatur, einem Knochen u. s. w. abgeplattet werden, bei der dadurch bewirkten, sehr bedeutenden Vergrösserung und unregelmässigen Gestaltung, auch um so ausgedehntere Verletzungen herbeiführen müssen. Es betrifft diese Bemerkung ganz besonders die nach dem Minié'schen System construirten Expansionsgeschosse, welche dem Umstande, dass sie in der Regel aus älteren, umgearbeiteten, d. h. glatten, später mit Zügen versehenen Gewehren geschossen werden, ihr ungewöhnlich grosses Caliber verdanken. Ausserdem erleiden dieselben schon dadurch, dass die in ihrer Basis enthaltene Höhlung theils durch die entzündeten Pulvergase allein, theils vermittelst eines in derselben enthaltenen eisernen Treibspiegels, auseinandergetrieben wird, um sich in die Züge des Gewehres zu legen, eine Formveränderung, welche, sobald eine durch Aufschlagen entstandene Abplattung hinzutritt, eine enorme sein kann. Am wenigsten ist eine erhebliche Formveränderung bei dem Langblei der preussischen Zündnadelwaffen zu erwarten, weil dasselbe noch am meisten der eigentlichen Kugelgestalt sich annähert.

Ich habe es für nicht überflüssig gehalten, die Beschreibung der verschiedenen Geschosse, von denen ich auch Maass- und

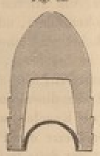
Gewichtsbestimmungen geben werde, durch die nachfolgenden, des Vergleiches wegen zusammengestellten Abbildungen in natürlicher Grösse zu erläutern, da selbst in der neuesten Schrift über Schusswunden, welche sich vorzugsweise mit den verschiedenen Projectilen beschäftigt, und deren auch eine beträchtliche Anzahl abbildet (Zechmeister, Die Schusswunden und die gegenwärtige Bewaffnung der Heere. Eine militärärztliche Skizze. München, 1864. 8. Mit 2 lith. Taff.), weder die neuen preussischen, noch die verschiedenen dänischen Geschosse sich bildlich dargestellt finden.

Preussische Geschosse.

Fig. 5.

Fig. 6.

Fig. 6a.



Dänische Geschosse.

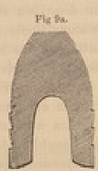
Fig. 7.

Fig. 8.

Fig. 8a.

Fig. 9.

Fig 9a.



In der preussischen Armee, welche, mit Ausnahme der Pioniere, gegenwärtig durchweg mit den bekanntlich von Dreyse

zu Sömmerda construirten Zündnadelwaffen versehen ist, ist hiernach das sogenannte Langblei derselben das am meisten verbreitete Geschoss. Dasselbe (Fig. 5.) besitzt ein Einheits-Caliber, sowohl für die Infanterie- und Füsilier-Gewehre, als auch die Zündnadel-Büchsen der Jäger und die Zündnadel-Carabiner der Kavallerie. Nach officiellen Angaben haben die gedachten Zündnadel-Waffen sämmtlich das Caliber von 58½—60 Hundertstel Zoll und wiegt das Langblei derselben 1,87 Loth, so dass 16 Stück auf ein Pfund gehen, wobei eine Toleranz von 0,2 Loth darüber und darunter gestattet ist (vgl. ausserdem die Maass- und Gewichts-Angaben weiter unten). Die Gestalt des Langbleies entspricht ziemlich genau der einer Eichel, und sitzt in der Patrone auch, wie eine solche, auf dem etwa ¼ Zoll dicken, ausgehöhlten, aus einer pappeartigen Masse angefertigten Zündspiegel, der in seiner Mitte einen kleinen Fleck hat, welcher die durch Abschnellen der Zündnadel in Brand zu setzende Explosivmasse enthält, die ihrerseits das hinter ihr, in der Patronenhülse befindliche Pulver entzündet. Es kommt übrigens vor, wie ich das gesehen habe, dass der Zündspiegel bei Schüssen, die aus grosser Nähe abgefeuert werden, mit der Kugel in den Körper eindringt.

Das Langblei-Geschoss war also dasjenige, welches preussischerseits im gegenwärtigen Kriege fast allein in Betracht kam, da die Fälle zu den sehr seltenen gehörten, in welchen die Pioniere, die mit den sogleich zu beschreibenden Minié-Geschossen versehen sind, von ihrer Schusswaffe Gebrauch machen mussten, ebenso wie die nach älteren Systemen calibrirten Pistolen der Kavallerie, sowie die Revolver der Offiziere für die grosse Zahl der Verwundungen nicht in Betracht zu bringen sind.

Die preussischen Minié-Kugeln der Pionier-Gewehre (Fig. 6, 6a), welche ein Caliber von 0,69—0,71 Zoll haben, sind Cylinder mit parabolischer Spitze, in ihrem unteren, cylindrischen Theile mit 3 Reifelungen versehen; das Geschoss enthält, wie der Durchschnitt (Fig. 6a) zeigt, eine beinahe 7 Par. Linien tief in dasselbe eindringende, oben quer abgeschnittene Höhlung, deren unterster, der Basis des Geschosses zunächst gelegener Theil, durch einen, noch nicht ½ Par. Linie dicken, eisernen Treibspiegel (culot), von der Gestalt einer abgeplatteten halben Hohlkugel eingenommen wird, dazu bestimmt, vermittelst der Expansion der Pulvergase, in die Höhlung des Geschosses hineingetrieben zu werden und dabei das Blei desselben auseinander- und in die Züge des Gewehres zu drängen.

Von den Geschossen der **dänischen** Armee habe ich 3 verschiedene Arten zu Gesicht bekommen; ich bin aber nicht im Stande, anzugeben, welches derselben das verbreitetste ist. Beim Oeffnen der in zahlloser Menge auf der Erde herumgestreut liegenden Patrontaschen, welche von den bei der Erstürmung der Düppeler Schanzen gefangen genommenen Dänen fortgeworfen werden mussten, fand ich am häufigsten das zuerst (Nr. 1, Fig. 7) zu beschreibende Geschoss des Dorngewehres, sah auch an den abgenommenen Gewehren fast durchweg die dazu gehörige Aushöhlung der Ladestöcke; demnächst fand ich am häufigsten das (Nr. 3, Fig. 9, 9a) beschriebene Expansionsgeschoss, und nur in zwei Exemplaren, deren eines bei einem preussischen Soldaten von mir herausgeschnitten wurde, habe ich die (Nr. 2, Fig. 8, 8a) beschriebene Spitzkugel gesehen.

1. **Cylindro-konisches Geschoss** (Spitzkugel) für das Dorngewehr nach **Delvigne-Thouvenin'schem** System (Fig 7), mit kurzem, einmal gereifeltem Cylinder und einem mehr als zweimal so langen, spitzigen Konus mit gewölbtem Mantel. Die Basis dieses Projectiles, welches leicht gefettet wird, ist ganz eben und wird dadurch, dass sie mit dem, in entsprechender Weise für die Spitze desselben ausgebohrten Ladestocke auf den im Grunde des Gewehres, in der Schwanzschraube, befindlichen Dorn fest aufgesetzt wird, auseinandergetrieben, und ist so im Stande, sich in die Züge des Gewehres zu legen.

2. **Cylindro-konisches Geschoss mit Höhlung** (Fig. 8, 8a); der Cylinder, beinahe eben so lang, wie der Konus, mit **einer** breiten und tiefen Reifelung versehen; die an dem Geschoss, wie an einer Minié-Kugel, vorhandene Höhlung (vgl. den Durchschnitt, Fig. 8a) hat eine Tiefe von 6 Par. Linien, ist viereckig und ihr oberes Ende wie eine vierseitige Pyramide beschaffen.

3. **Minié-Kugel** (Fig. 9, 9a), von derselben Gestalt, wie das oben beschriebene preussische Expansionsgeschoss, nur mit geringer Abplattung der Spitze der Kugel, die wahrscheinlich beim Durchschneiden von zwei gleichzeitig gegossenen, sich mit den Spitzen berührenden Projectilen entsteht. Die Höhlung dieses Geschosses ist mehr als $7\frac{1}{2}$ Par. Linien tief, und, wie der Durchschnitt (Fig. 9a) zeigt, an ihrem oberen Ende kuppelförmig; ein Treibspiegel ist bei diesem Geschoss nicht vorhanden.

Zum Schluss stelle ich die von mir genommenen Maasse und Gewichte der eben beschriebenen Projectile übersichtlich

zusammen, und bemerke, dass die ersteren in **Pariser Linien**, die letzteren in **Medicinal-Gewicht** ausgedrückt sind.

Art der Geschosse	Grösste Länge oder Höhe.	Grösste Breite oder Dicke.	Gewicht.		
	Par. Linien.	Par. Linien.	Drachm.	Gran.	Gran.
Preuss. Langblei (Fig. 5)	$12\frac{1}{2}$	6	8	50	= 530
" Minié-Kugel (Fig. 6, 6a)	$13\frac{1}{2}$	$7\frac{1}{2}$	13	19	= 799
Dänische Spitzkugel für das Dorngewehr (Fig. 7)	11	7			
" Spitzkugel mit Höhlung (Fig. 8, 8a)	$11\frac{1}{2}$	$7\frac{1}{2}$	10	44-73	=644-673
" Minié - Kugel (Fig. 9, 9a) . .	$13\frac{1}{2}$ (nicht ganz).	8	14	11-22	=851-862

3. Zur Statistik der Kriegswunden.

Wenn auch in jedem Kriege, abhängig von der Art des Kämpfens, den zur Anwendung kommenden Waffen und Geschossen, der Charakter der durch die letzteren hervorgerufenen Verwundungen ein anderer ist, und sich die in dem einen Kriege hinsichtlich derselben gemachten Erfahrungen nicht ohne Weiteres auf einen anderen übertragen lassen, so ist es doch nicht ohne Interesse, für jeden derselben, oder für einzelne hervorstechende Actionen aus demselben, die Proportion zwischen den tödtlichen, den schweren und leichten Verwundungen aufzusuchen, ferner das Verhältniss der Verletzungen durch Gewehr-, Artillerie-Projectile und blanke Waffen zu einander, sowie die Vertheilung der Verwundungen auf die einzelnen Körpertheile, nach vorliegenden zuverlässigen Daten, festzustellen.

Um zunächst eine Uebersicht über die Proportion der tödtlichen, schweren und leichten Verwundungen zu geben, habe ich aus den amtlichen Verlust-Listen (Militair-Wochenblatt, 1864, Nr. 9, 11, 13, 14, 16, 17, 18, 20, nebst den Nachträgen und Berichtigungen in Nr. 16, 18) die nachfolgende Zusammenstellung der von der preussischen Armee seit dem Uebergange über die Eider bis nach Erstürmung der Düppeler Schanzen erlittenen Verluste, mit besonderer Berücksichtigung der bedeutenderen Gefechtstage, namentlich zur Erinnerung für diejenigen Collegen, welche den einzelnen Kämpfen beigewohnt haben, angefertigt:

Verluste der preussischen Armee vom 2. Febr. bis 27. April 1864:	†	Verwundet schwer	Verwundet leicht	Vermisst oder gefangen.	Summa.
Gefecht bei Missunde, 2. Februar	33	67	92	5	197
Vorpostengefechte im Sundewitt bis zum 16. März	16	21	28	5	70
Gefechte bei Düppel und Rackebüll, Verlust in den Enfilir-Batterieen auf Broacker am 17. März	29	47	62	—	138
Vorpostengefechte und in den Batterieen bis zum 27. März	2	3	5	2	12
Vorpostengefecht bei den Düppeler Schanzen am 28. März	23	51	81	32	187
Vorpostengefechte vom 30. März bis 6. April	5	22	40	—	67
Vor Düppel und in den Batterieen vom 7. bis 17. April	27	44	78	2	151
Erstürmung der Düppeler Schanzen am 18. April	224	447	478	39	1188
Auf Vorposten am 19. und 27. April	—	1	1	—	2
Combin. Garde-Inf.-Divis. v. 23. Febr. bis 8. März	2	7	15	34	58
" " " " v. 17. bis 21. März (vor Fridericia)	5	14	13	—	32
In Jütland bei Hjortsballe-Kro, Kirkeby, Halk, Süderballig, Torsteet vom 30. März bis 22. April	—	2	3	22	27
Total-Summe	366	727	895	141	2129
		1622			

Bei näherer Betrachtung obiger Ziffern fällt zuvörderst die zur Zahl der Verwundeten (1622) sehr beträchtliche Menge der Todten (366) auf, indem danach auf ungefähr 4½ Verwundete (einschliesslich der bloss Contundirten, oder ganz leicht, oft nur durch einen Hautritz Verletzten) immer ein Todter kommt. Diese Proportion gestaltete sich in Wirklichkeit aber noch insofern erheblich ungünstiger, als auch unter der Zahl der Schwerverwundeten sich noch Viele befanden, die zwar bei Aufstellung der Verlustlisten noch lebten, aber doch dem sicheren Tode verfallen waren, so dass, wenn man diese zahlreichen, kurze Zeit nach der Verwundung Gestorbenen, wie man es muss, zu den tödtlichen Verletzungen hinzurechnet, die Zahl der letzteren zu den übrigen sich mit grosser Wahrscheinlichkeit wie 1 : 4 stellen würde. Es ist diese sehr ungünstige Proportion allerdings theilweise auf die verhältnissmässig ziemlich zahlreichen Verletzungen durch grobes Geschütz (Kartätschen, Granaten, Bomben), wie sie namentlich in dem Gefecht von Missunde, ferner während und bei

der Belagerung von Fridericia und der Düppeler Schanzen, so wie bei der Erstürmung der letzteren beobachtet wurden, zum grösseren Theile aber auf die im vorigen Abschnitt besprochene verheerende Wirkung der heutigen, gezogenen Feuerwaffen zu beziehen, indem, wie schon erwähnt, nicht nur die Treff- und Tragfähigkeit derselben, im Vergleich zu den früheren glatten Gewehren, eine sehr viel grössere geworden ist, sondern auch die Verwundungen selbst, aus den bereits oben angegebenen Gründen, viel schlimmere und gefährlichere als ehedem sind. Ebenso spricht der Umstand, dass die schweren und die leichten Verwundungen (eine Unterscheidung, die sich allerdings nicht streng wissenschaftlich begründen und durchführen lässt) in der obigen Zusammenstellung der Zahl nach als fast ganz gleich erscheinen, wenn auch ein geringer Ueberschuss auf Seiten der leichten Verwundungen vorhanden ist, dafür, dass die Gefährlichkeit der heutigen, weittragenden Gewehre eine viel bedeutendere ist, als die der ehemals allgemein gebräuchlichen, bei denen die Zahl der durch matte Kugeln bewirkten Prellschüsse jedenfalls viel grösser war.

Aus der nachstehenden Uebersicht über die bei der Erstürmung der Düppeler Schanzen stattgehabten Verwundungen, deren Zahl weit die Hälfte aller übrigen, während des ganzen Feldzuges vorgekommenen Verwundungen zusammengenommen übersteigt, soll ersichtlich gemacht werden, welcher Art dieselben bezüglich ihrer Entstehung durch Gewehrschüsse, Artillerie-Projectile und blanke Waffen waren, ferner, in welcher Proportion die einzelnen Körpertheile von den Verletzungen betroffen wurden. Allerdings sind in beiden Beziehungen die für die Zusammenstellung benutzten Grundlagen, nämlich die amtlichen Verlust-Listen, als ungenügend zu bezeichnen, da die Angaben derselben vielfach der, wenigstens für wissenschaftliche Zwecke, unumgänglichen Genauigkeit entbehren; da indessen bis jetzt noch keine anderen Quellen, aus denen ich hätte schöpfen können, vorliegen, so habe ich das vorhandene Material so gut, als es anging, benutzt, und aus demselben, wie ich glaube, wenigstens annähernd richtige Resultate erhalten. Ich will noch bemerken, dass ich alle in den Verlust-Listen als „Schuss" oder „Schussverletzung" bezeichneten Verwundungen zu den Gewehrschüssen gezählt habe, obgleich darunter sich auch einige Kartätschschüsse befinden mögen, dass ferner diejenigen Verwundeten, bei denen in der Liste die Art ihrer Verwundung, ob leicht oder schwer, fraglich geblieben ist, von mir zu den ersteren gerechnet worden sind.

Die Verwundungen bei der preussischen Armee bei Erstürmung der Düppeler Schanzen, 18. April 1864.

Körpertheil.	Gewehrschüsse.				Granat-Verwundungen.				Kartätsch-Verwundungen.				Bajonett-, Säbel-Verwundungen.				Summa.			
	†	schwer.	leicht.	Summa.	†	schwer.	leicht.	Summa.	†	schwer.	leicht.	Summa.	†	schwer.	leicht.	Summa.	†	schwer.	leicht.	Summa.
Kopf	71	19	33	123 [1])	2	5	3	10	3	2	—	5	—	—	—	—	76	26	36	138
Gesicht	5	21	20	46	—	1	5	6	—	1	—	1	—	—	3	3	5	23	28	56
Hals und Nacken	5	7	5	17 [2])	—	1	1	2	—	—	1	1	—	—	—	—	5	8	7	20
Brust	52	42	4	98 [3])	2	1	2	5	5	1	1	7	—	—	—	—	59	44	7	110
Unterleib, Becken	14	33	2	49 [4])	2	—	1	3	3	1	—	4	—	—	—	—	19	34	3	56
Rücken, Lenden, Kreuz	2	11	13	26 [5])	—	2	2	4	1	—	—	1	—	—	—	—	3	13	15	31
Hüfte	—	4	5	9	—	2	1	3	—	—	—	—	—	—	—	—	—	6	6	12
Gesäss	—	2	2	4	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	4
Genitalien	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	1	1
Schulter	1	40	24	65 [6])	—	—	7	7	—	—	—	—	—	—	1 [10])	1	1	40	32	73
als „Arm" bezeichnet	—	29	30	59 [7])	—	2	1	3	—	1	—	1	—	—	—	—	—	32	31	63
Oberarm	—	18	20	38 [7])	—	1	—	1	—	—	—	—	—	—	—	—	—	19	20	39
Vorderarm	—	16	5	21 [7])	—	—	—	—	—	—	—	—	—	—	—	—	—	16	5	21
Hand	—	16	55	71	—	1	5	6	—	—	—	—	—	—	2 [11])	2	—	17	62	79
als „Bein" bezeichnet	1	17	2	20 [8])	—	1	—	1	—	—	—	—	—	—	—	—	1	18	2	21
Oberschenkel	2	49	37	88 [8])	—	3	2	5	—	2	1	3	—	—	1	1	2	54	41	97
Knie	—	16	6	22 [8])	—	—	—	—	—	—	—	—	—	1	—	1	—	17	6	23
Unterschenkel	—	23	37	60 [8])	—	1	1	2	—	1	—	1	—	—	1	1	—	25	39	64
Fuss	—	18	36	54 [9])	—	4	7	11	—	1	—	1	—	1	3	4	—	24	46	70
Summa	153	381	336	870	6	25	39	70	12	10	3	25	—	2	11	13	171	418	389	978
Dazu kommen noch:																				
Abreissung von Armen oder Beinen	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	8	—	9
Contusionen	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	53	53
nicht näher bezeichnete leichte Verwundungen	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36	36
nicht näher bezeichnete schwere Verwundungen	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21	—	21
nicht näher bezeichnete Tödtungen	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	52	—	—	52
Summa summarum	153	381	336	870	6	25	39	70	12	10	3	25	—	2	11	13	224	447	478	1149

[1]) Darunter 8 Mal noch anderweitige Verletzungen. [2]) Darunter noch 2 anderweitige Verletzungen. [3]) Darunter noch 19 anderweitige Verletzungen. [4]) Darunter noch 4 anderweitige Verletzungen. [5]) Darunter noch 1 anderweitige Verletzung. [6]) Darunter noch 8 anderweitige Verletzungen. [7]) Darunter noch 13 anderweitige Verletzungen. [8]) 7 Mal gleichzeitig Verletzung beider Beine, 2 Mal Schuss durch beide Kniee und 3 Mal noch anderweitige Verletzungen. [9]) 5 Mal gleichzeitig Verletzungen beider Füsse. [10]) Säbelhieb und [11]) ein Säbelstich.

Während aus der vorstehenden Tabelle sich ergiebt, dass die **Gewehrschusswunden** mehr als 8mal so häufig als Granat-, Kartätsch-, Bajonett- und Säbel-Verwundungen zusammengenommen vorkamen, ist doch hinsichtlich der Verletzungen durch **Artillerie-Projectile** jedenfalls die Ziffer zu vergrössern, indem die 9mal beobachteten Abreissungen von Armen und Beinen (je 3mal der „Arm" und das „Bein", 2mal „beide Beine" durch Granaten, 1mal der „Fuss" durch eine Kartätsche abgeschossen) hierher gehören, und unter den 52 sonst nicht näher bezeichneten Tödtungen sich wenigstens 6 durch Granaten und 1 durch 3 Kartätschkugeln befinden, ebenso wie unter den 53 Contusionen sicher, und den 57 nicht näher specificirten schweren und leichten Verwundungen mit grösster Wahrscheinlichkeit auch solche zu suchen sind. Sehr auffallend bleibt dagegen die geringe Zahl (13) von Verwundungen durch *blanke Waffen*, unter denen nur 2mal Säbel-Verwundungen durch Hieb oder Stich (wahrscheinlich durch dänische Officiere) notirt sind, während die übrigen das Bajonett betrafen und grösstentheils leichte waren. Unter den 53, durchweg als leichte Verletzungen bezeichneten *Contusionen*, befinden sich theils solche, die durch Kugeln oder Granatsplitter hervorgerufen wurden, also leichte Prellschüsse, theils eine Anzahl von Verstauchungen, besonders von Fuss und Hand, beim Hinunterspringen in die Schanzengräben entstanden. Ferner sind zu den leichten, nicht näher bezeichneten Verwundungen 1 Verbrennung des Gesichtes durch Geschützfeuer und 1 durch Ueberfahren beider Unterschenkel mit einem Geschütz entstandene Verletzung, sowie zu den schweren Verwundungen 1 Unterleibsverletzung durch Fallen auf einen Pfahl gezählt worden.

Betrachten wir jetzt die Verwundungen der einzelnen Körpertheile, so ist zunächst die grosse Zahl von Verletzungen des *Kopfes*, mit Rücksicht auf den vergleichsweise geringen Umfang desselben, auffallend, indem die Verwundungen desselben und des Gesichtes (194) fast genau $\frac{1}{4}$ aller übrigen, näher bezeichneten Verletzungen ausmachen. Unter den Verwundungen des Kopfes sind 2 tödtliche Fälle, in denen resp. 2 und 3 Schüsse in denselben erfolgten, sowie 6 andere, bei welchen noch anderweitige Verwundungen (in die Brust 3mal, Schulter, Bauch, Nacken, Bein, beide Beine je 1mal) stattfanden. — Von den Verletzungen des *Gesichtes* sind näher bezeichnet an *leichten* Verwundungen solche der Nase (5), des Ohres (2), der Oberlippe (1), der Backe (10), des Kinnes (2), am Auge (3), sowie an *schweren*: der Backe (7), der Backe und des Kinnes (1), Backe und Schläfe (8), quer durch das Gesicht (1), das Kinn (4), durch den Mund (2), endlich an *tödtlichen*: je 2 durch das Auge und den Mund und 1 durch die Kinnlade. — Auch die Zahl der tödtlichen und schweren *Brustverletzungen* ist sehr erheblich (103), zumal zu denselben noch 19 anderweitige bedeutende Verwundungen (nämlich 10mal des Armes, darunter 1mal beider Arme, je 2mal der Schulter, des Halses, Beines, und je 1mal des Unterleibes und Kreuzes) hinzukommen, welche 4mal alsbald tödtliche Fälle betrafen. — Die Verwundungen der

Schulter vertheilen sich in Proportionen, welche, wegen Mangels näherer Angaben, nicht genauer festgestellt werden können, theils auf die Ober- und Unterschlüsselbein-, die Schulterblattgegend und Schulterhöhe, theils auf das obere Ende des Oberarmes, namentlich den Oberarmkopf; ich habe deshalb in einer der nachstehenden summarischen Zusammenstellungen der Verwundungen nach den einzelnen Regionen des Körpers, diejenigen der Schulter denen des Rumpfes und der oberen Extremität zur Hälfte zugetheilt. — Bei den die *Gliedmaassen* betreffenden Verwundungen ist in den Verlust-Listen leider die für den weiteren Verlauf und die Heilung so überaus wichtige Unterscheidung, ob mit oder ohne Knochenverletzung, nicht durchweg gemacht; auch lässt sich nach denselben eine genauere Vertheilung der Verletzungen auf die einzelnen Abschnitte der Gliedmaassen und deren Gelenke nicht durchführen, da die Zahl der Fälle mit unbestimmten Bezeichnungen, wie „Arm", „Bein" sehr erheblich ist; bloss die 23 Verletzungen am Knie und des Kniegelenkes sind unterschieden, darunter 2 mit gleichzeitiger Verletzung beider Kniee. Was überhaupt die *gleichzeitigen* Verwundungen *beider* Unterextremitäten anlangt, so sind diese an den „Beinen" durch Schüsse 6mal, durch Granaten 1mal und am Fusse durch erstere 2mal, durch letztere 3mal vertreten.

Wenn man aus der obigen grösseren Tabelle die näher specificirten Verwundungen, nach Kopf, Hals, Rumpf und Extremitäten vertheilt, zusammenstellt, so erhält man das in nachstehenden Zahlen ausgedrückte Resultat, dass die Häufigkeit der Verwundungen des Rumpfes, der oberen und unteren Extremitäten nahezu dieselbe war:

Kopf und Gesicht	194
Hals und Nacken	20
Rumpf (Brust, Unterleib, Rücken, Lenden, Kreuz, Hüften, Gesäss, Genitalien und die eine *Hälfte* der Schulterverwundungen)	$250\frac{1}{2}$
Obere Extremitäten (nebst der anderen *Hälfte* der Schulterverwundungen)	$238\frac{1}{2}$
Untere Extremitäten	275
	978

Nimmt man jedoch eine Vertheilung der Verletzungen auf die obere und untere Körperhälfte vor, indem man ungefähr die Gegend des Nabels als die Grenze beider betrachtet, so ergiebt sich ein sehr beträchtliches Ueberwiegen der Zahl der Verwundungen an der oberen Körperhälfte, namentlich an Kopf, Brust und Schultern, über die nur wenig mehr als halbmal so grosse Menge der die untere Körperhälfte betreffenden Verletzungen:

Obere Körperhälfte (Kopf, Gesicht, Hals und Nacken, Brust, obere Extremitäten, die eine Hälfte der Unterleibs- und Rückenverletzungen)	642½
Untere Körperhälfte (die andere Hälfte der Unterleibs- und Rückenverletzungen, Hüften, Gesäss, Genitalien, untere Extremitäten	335½
	978

Das vorstehend nachgewiesene Missverhältniss zwischen der Zahl der Verletzungen an der oberen und unteren Körperhälfte, wie es keinesweges in dem etwas grösseren Flächenraume, den die erstere, gegenüber der zweiten besitzt, seine Begründung findet, pflegt in offenen Feldschlachten nicht vorzukommen, vielmehr scheinen in solchen die Verwundungen der unteren Extremitäten die häufigsten zu sein, nach Erfahrungen, welche in den früheren Schleswig-Holsteinischen Feldzügen (Djörup) und im italienischen des Jahres 1859 (H. Demme) gemacht worden sind. Dagegen steht die vorliegende Beobachtung keinesweges vereinzelt da, indem auch bei der Belagerung von Sebastopol, aus leicht erklärlichen Gründen, dieselbe bedeutende Frequenz der Kopf- und Brustwunden (nach Scrive) vorhanden war, wie bei der unter ähnlichen Umständen ausgeführten Erstürmung der Düppeler Schanzen.

4. Ueber Granat-Verwundungen.

Granaten sind bekanntlich eiserne Hohlgeschosse, welche, mit einer Sprengladung gefüllt, bei oder kurz vor Erreichung des Zieles durch jene aus einander, in viele einzelne Stücke zersprengt werden. Die früher allein gebräuchlichen sphärischen Hohlgeschosse sind in der Neuzeit, bei Anwendung gezogener Geschütze, durch cylindro-konische Projectile, die ihrer Gestalt nach den oben beschriebenen Minié-Kugeln sehr ähnlich sind, ersetzt worden. Allerdings wurde im gegenwärtigen Kriege dänischerseits auch noch von den älteren sphärischen Geschossen Gebrauch gemacht, allein es kamen doch grösstentheils die sogenannten gezogenen Granaten, und auf Seite der Preussen ausschliesslich solche in Betracht. Die gezogenen Granaten stellen hohle Eisen-Cylinder mit parabolischer Spitze dar, in welche letztere die Zündvorrichtung eingeschraubt ist, die bei den dänischen Granaten noch aus dem in früheren Zeiten aus-

schliesslich gebrauchten, auf eine gewisse Brennzeit berechneten, d. h. tempirten, Zünder besteht, der gelegentlich verlöschen, oder zu schnell oder zu langsam abbrennen kann, daher das Exploдiren ziemlich häufig gar nicht, oder zu früh, oder zu spät stattfindet, und im ersten Falle das Geschoss nur durch seine Schwere und Propulsivkraft einwirkt, in den beiden letzten Fällen aber unschädlich in der Luft oder in der Erde u. s. w. crepirt. Bei den preussischen gezogenen Granaten jedoch erfolgt die Zündung durch Percussion, indem erst beim Aufschlagen des Geschosses ein in die Spitze desselben beim Laden eingeschraubter Bolzen in eine Zündmasse hineingetrieben wird, die Sprengladung entzündet und das Geschoss auseinandertreibt. Allerdings sind diese Granaten, welche nur bei Hinterladungs-Geschützen, deren die Dänen nicht besassen, zur Anwendung kommen können, auch beim Laden gefährlicher zu handhaben, da, wie mir ein vorgekommener Fall bekannt ist, der mehreren Artilleristen das Leben kostete, wenn der zur Sicherheit zwischen dem Bolzen und der Explosivmasse der Quere nach lose eingeschobene Draht (Vorstecker), der während des Fliegens des Geschosses von selbst wieder herausgeschleudert wird, beim Laden, in Folge eines Missgeschickes, z. B. des Ausgleitens des Mannes, heraus- und das ganze Geschoss zu Boden fällt, auch dann schon eine Explosion, mit ihren fürchterlichen Folgen, stattfindet. Damit die eisernen cylindro-konischen Geschosse sich in die Züge der Kanone, ohne letztere zu ruiniren, legen können, muss ein weiches Metall als Vermittelung benutzt werden, und dieses ist bei den preussischen gezogenen Granaten Blei, welches um den mit tiefen Reifelungen versehenen cylindrischen Theil des Geschosses, in Form eines denselben ganz umhüllenden Mantels gegossen wird, während an den dänischen gezogenen Granaten nicht die ganze cylindrische Oberfläche mit einem weichem Metall bedeckt ist, sondern an ihr nur 12 in gewissen Abständen und in zwei Reihen eingesetzte knopfartige Führungen aus einer Compositionsmasse sich befinden (vgl. das Sprengstück Fig. 10), welche den directen Contact des eisernen Geschosses mit der Innenwand der Kanone verhindern und das Hineinlegen in die Züge derselben möglich machen. Die zur Anwendung gekommenen Granaten waren auf beiden Seiten die sogenannten 12- und 24pfündigen, deren in Wirklichkeit viel erheblichere Gewichte (da die Bezeichnung nur das Gewicht von entsprechenden steinernen Geschossen ungefähr ausdrückt) ich nachstehend mittheile; für die preussischen Geschosse nach den officiellen Angaben, für die dänischen nach Wägungen, welche auf meine Veranlassung mit nicht explodirt aufgefundenen Exemplaren vorgenommen wurden:

Theile der gezogenen Granaten.	Preussische				Dänische	
	24lbge		12lbge		24lbge	12lbge
	Pfd.	Lth.	Pfd.	Lth.	Pfd	Pfd.
Das eiserne Hohlgeschoss	36	14	17	18	} 48	25
Der Bleimantel	16	8	10	14		
Die Sprengladung	1	25	1	—	—	—
Der Bolzen	—	4	—	4	—	—
Total-Gewicht	54	21	29	6	48	25

Wenn ich noch hinzufüge, dass von den dänischen gezogenen Granaten die 24pfündigen eine Höhe von 1 Fuss, und einen Durchmesser von 6 Zoll besitzen, und dass erstere bei den 12pfündigen 9 Zoll und letzterer 4 Zoll beträgt, während die Dimensionen bei den gezogenen preussischen Granaten etwas geringer sind, kann man sich eine Vorstellung davon machen, welche Verheerungen ein solches Geschoss anrichten muss, wenn es, ohne explodirt zu sein, bloss seinen Umfang, seine Schwere und seine Propulsivkraft zur Geltung bringt. Dass dadurch ganze Gliedmaassen weggerissen, Körpertheile zu Brei zermalmt werden können, liegt auf der Hand; während beim Aufschlagen unter einem sehr stumpfen Winkel, in Folge der dabei auf das Nervensystem einwirkenden Erschütterung, fast immer Brand des betreffenden Körpertheiles zu erwarten ist. Indessen auch die viel häufigeren Verwundungen durch Sprengstücke, die sogen. „Splitter", welche indessen handgross und darüber sein können, andererseits aber auch bis in feine, bloss die Epidermis durchdringende Eisenpartikel zertheilt gefunden werden, können die furchtbarsten Zerreissungen der Weichtheile und Zermalmungen der Knochen herbeiführen. Man betrachte das nachstehend (Fig. 10) in halber natürlicher Grösse abgebildete Sprengstück einer gezogenen 24pfündigen dänischen Granate, an welchem Stücke man die eine knopfförmige Führung (mit den Eindrücken der Züge versehen) erhalten, von 3 anderen aber die Höhlungen angedeutet sieht, in denen das Zerspringen des sonst etwa ¾ Zoll dicken Geschosses stattgefunden hat, und man denke sich ein solches, beinahe handgrosses Stück, mit seinen scharfen Bruchkanten und -Ecken und mit grosser Kraft auf einen menschlichen Körpertheil aufschlagend, und man wird die daraus hervorgehenden Verwundungen leicht ermessen können. Es ist natürlich bei den grösseren Sprengstücken von der Kraft

und dem Winkel, unter welchem sie den Körper treffen, abhängig, ob z. B. an den Gliedmaassen bloss die Weichtheile in oft enormen Wunden zerrissen, oder ob gleichzeitig auch die Knochen zerschlagen werden, während, wenn ein solches Sprengstück die Wandungen einer Leibeshöhle trifft, die letztere leicht dadurch eröffnet wird, auch jenes in sie eintritt und eine oft sofort tödtliche Verletzung zufügt. Kleine, hasel- bis wallnussgrosse Sprengstücke indessen dringen ganz ähnlich, wie Kugeln, in die Gewebe ein, richten in denselben keine geringeren Störungen, als jene, an, und müssen wie dieselben ausgezogen oder ausgeschnitten werden. Die ganz kleinen Sprengstücke endlich, die oft nicht grösser als Pulverkörner sind, findet man bisweilen in zahlloser Menge wie in die Haut hineingesäet vor, und stellen dieselben eine natürlich ungefährliche, aber, bei der grossen Zahl der kleinen Verwundungen, ziemlich schmerzhafte Verletzung dar, bei welcher man durch ein mühsames Ausgraben mit einer Staarnadel oder ähnlichen Instrumenten, die in der Haut festsitzenden, kleinen, fremden Körper herausheben kann. — Die durch Sprengstücke bewirkten blossen Verletzungen der Weichtheile, deren ich einige von sehr bedeutenden Dimensionen, nämlich von mehreren Fussen Länge, gesehen habe (ich erinnere mich namentlich eines Falles, in welchem längs der ganzen Hinterfläche des Oberschenkels eine bis in die Muskeln eindringende, enorme Wunde bestand, so wie mehrerer ähnlicher ausgedehnter Verletzungen des Gesässes), verhalten sich den gewöhnlichen Risswunden ganz ähnlich; sie sind, ebenso wie diese, nachdem die entsprechenden Abstossungen nekrotisirter Massen stattgefunden haben, je nachdem die Verletzung tiefer, oder weniger tief eingreift, heilbar, die Vernarbung aber, bei dem oft sehr bedeutenden Substanzverluste an Haut, sehr langsam, und, wenn nicht bei der Behandlung die grösste Umsicht obwaltet, oft nicht ohne Deformität, als Folge der Narben-Contraction, zu erwarten. Sind

Fig. 10.

jedoch an den Extremitäten, zugleich mit den Weichtheilen, die Knochen mehr oder weniger comminutiv gebrochen, so ist fast immer die dringendste Indication zur sofortigen Absetzung des Gliedes vorhanden, weil an den Versuch einer Erhaltung desselben, selbst wenn die grossen Gefäss- und Nervenstämme unverletzt geblieben sind, nicht ohne äusserste Gefährdung des Lebens des Verletzten gedacht werden kann. So mussten beispielsweise im leichten Feld-Lazareth zu Broacker, während meiner Anwesenheit daselbst, kurz vor der Erstürmung der Schanzen, an einem Tage zwei Exarticulationen im Schultergelenk wegen ausgedehnter Granat-Verletzungen der Weichtheile und Knochen der oberen Extremität ausgeführt werden.

Ueber die durch preussische gezogene Granaten zugefügten Verletzungen besitze ich zwar keine eigenen Erfahrungen, allein nach den Sprengstücken, die ich, nach Erstürmung der Düppeler Schanzen, in und bei denselben in grosser Zahl gefunden habe, zu urtheilen, ist anzunehmen, dass jene ganz derselben Art, wie die oben beschriebenen, sein müssen. Dazu kommen aber noch die, jedenfalls auch beobachteten Verletzungen durch den den Körper der Granate umhüllenden Bleimantel, welcher, wie wir oben gesehen haben, bei den 24- und 12pfündigen Granaten für sich allein schon ein Gewicht von resp. mehr als 16 und mehr als 10 Pfd. besitzt, und nicht, wie es scheint, mit dem Eisengeschoss in entsprechend kleine Stücke zersprengt wird, sondern sich, wahrscheinlich seiner Zähigkeit wegen, beim Explodiren des Projectiles, in grossen, schweren, überaus unregelmässigen, scharfkantigen Flatschen abstreift, wie ich solche ebenfalls bei den Schanzen vielfach herumliegen zu sehen Gelegenheit hatte. Es ist anzunehmen, dass auch durch diese Umhüllnng die furchtbarsten Zerreissungen herbeigeführt werden müssen.

Was die Häufigkeit der Granat-Verletzungen anlangt, so wurden, abgesehen von dem Gefechte bei Missunde, welches grossentheils in einem Artilleriekampfe bestand, und bei der Beschiessung von Fridericia, über welche beide ich aus eigener Erfahrung nichts anzugeben vermag, solche vom 17. März an, wo man, nach Erstürmung der Dörfer Rackebüll und Düppel, bis in den Schussbereich der Schanzen gekommen war, bei jedem weiteren Vorgehen und dem Fortschreiten der Belagerungsarbeiten vielfach beobachtet. Nicht nur wurden bei den bedeutenderen Gefechten, wie dem am 28. März, die zur Zurücktreibung der dänischen Vorposten vorgehenden Infanterie-Colonnen,

so wie nach Beginn der Belagerungsarbeiten die beim Ausheben der Parallelen und Laufgräben verwendeten Mannschaften von den Schanzen aus mit Granaten und Kartätschen stark beschossen, sondern auch die Batterieen, sowohl die bei Gammelmark, auf der Halbinsel Broacker, als auch die später in der Front vor den Schanzen errichteten, litten hauptsächlich durch Granatfeuer. Allerdings waren, bei den getroffenen Vorsichtsmaassregeln, die Verluste in den Batterieen im Ganzen nicht sehr erheblich, allein es kamen doch hier und da Verletzungen durch Granaten direct, oder durch von diesen in Bewegung gesetzte oder zerschmetterte andere feste Körper, namentlich Holzbalken- und -Splitter, sowie Stein- und Erdreichstücke vor, wobei auch mehrfach bloss einfache Knochenbrüche, ohne gleichzeitige Wunden der Weichtheile, beobachtet wurden. — In Betreff der Zahl der bei Erstürmung der Düppeler Schanzen vorgekommenen Granat-Verwundungen haben wir oben bereits einige genauere Angaben gemacht.

Gedruckt bei Julius Sittenfeld in Berlin.

[illegible] die Register der [illegible] die beim Ansehen der [illegible] und Längenkreise verwendeten Bezeichnungen von den [illegible] und [illegible] und Kartenblättern [illegible] [illegible] sondern auch die [illegible] sowie die [illegible], auf der [illegible] [illegible], als auch die später in den Text [illegible] [illegible], deren Lage [illegible] durch Gradangabe [illegible] [illegible], während bei den [illegible] Verzeichnissen [illegible] die [illegible] in den [illegible] nicht [illegible] [illegible] [illegible] [illegible] [illegible] durch [illegible] [illegible] oder durch [illegible] in [illegible] gemacht [illegible] [illegible] [illegible] [illegible] [illegible] sowie [illegible] und [illegible], wobei auch [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] der Zahl der [illegible] der [illegible] [illegible] [illegible] [illegible] haben, wir [illegible] [illegible] [illegible] gemacht.

[illegible]

THE INFLUENCE OF THE PRESENT KNAPSACK AND ACCOUTREMENTS ON THE HEALTH OF THE INFANTRY SOLDIER.

By W. C. Maclean, Esq., M.D., Deputy Inspector-General, Professor of Military Medicine, Army Medical School, Netley.

From the Journal *of the* Royal United Service Institution, *vol.* viii.

Mr. Chairman and Gentlemen,—I purpose this evening to call your attention to the influence of the present knapsack and accoutrements on the health of the infantry soldier.

Whatever may have been the case in times past, it is certain that everything bearing on the health and happiness, the moral, and physical well-being of the soldier, is now a subject of anxious consideration to the authorities, and of interest to the community at large.

After much careful inquiry into barrack and hospital accommodation, including the important subjects of ventilation, drainage, and surface space, very considerable improvements have been carried out, with the results of diminishing sickness and mortality in a very remarkable manner. Increased attention to clothing, food, moral, and intellectual training, and wholesome recreation, has gone hand in hand with the other improvements, and materially contributed to the end in view.

Among the improvements just mentioned, few were more imperatively called for than those affecting clothing. If time and the occasion admitted, it would not be a difficult task to show, that for a long period of time the inventive genius and good sense of this country were not seen to much advantage in military costume. The "follies of the wise" have often been conspicuous in the clothing and equipment of our soldiers. The generation familiar with heads laboriously soaped, powdered, plastered, and pigtail-tied, has only just passed away. The satirist who sang—

> "God bless the Guards, tho' worsted Gallia scoff;
> "God bless their pigtails, tho' they're now cut off,"

has not long disappeared from the clubs of London.

It is only within the last few years that any difference worth naming, was to be seen in the dress of the British soldier in Calcutta, and one quartered at Chatham.* A very few years ago I saw a batch of unhappy recruits learning their drill at Arcot, the hottest station in the hot Carnatic, buttoned up in red jackets, lined with stout serge, that had been served out to protect them from the cold of the English Channel.

The great bulk of the British army embarked for service in the Crimea, clothed in tight-fitting coats, the skirts of which had been pared away until nothing remained but a ridiculous appendage, fondly imagined by tailors to resemble the tail of a swallow. We still see these garments in Monmouth-street, and on the persons of deputy-lieutenants of counties, on occasions of state. In the museum at Netley, we have a collection of military head-dresses, most wonderful to look at. Yet they were very dear to their contrivers, and—in another sense—to those who had to carry them on their heads in all climates, from Canada to Cawnpore. Most of them, I have no doubt, are familiar to many gallant officers present; they are old acquaintances of my own, for I may truly say I have seen nearly all of them "Dance into light, and die into the shade." We preserve them for the wonder, if not for the admiration, of generations to come. Then we had the leather stock, we all remember it well; how long it stood its ground, how hard it was to get rid of; and I have no doubt that, like myself, some of my audience are acquainted with a few elderly friends who cherish the memory of that garotting apparatus to this day.

Forgive this retrospect at past errors; trivial, ludicrous even as some of them now appear, they were each in their time and degree causes of suffering, sickness, and premature death.

If we have made mistakes, let us not be ashamed to own them, and let careful study teach us to avoid them for the future. On my appointment, three years ago, to the chair of military medicine, in the Army Medical School, I was placed in a position where I could study on a large scale the chief causes which influence the health of the army. As at Fort Pitt formerly, so now at Netley, the invalids from all parts of the world may be said to pass in review before the

* Professor Longmore assures me that the tunics and trowsers issued to his old regiment in Bengal, during the mutiny, were heavier than those worn in Canada.—W.C.M.

medical officers of that great establishment, who have thus an opportunity of examining men who have served in almost every region of the globe, and observing on their persons the effects of service in various climates, and the influences hostile to health to which they have been exposed; and while it is the chief duty of the Professors of the School of Military Medicine to teach the young medical officers the many valuable lessons derived from such an immense field of observation, it is no less their duty, from time to time, to give to the authorities such information as may lead to improvements calculated to promote the health and happiness of the soldier, to diminish suffering and mortality; to lessen cost, and promote efficiency. It is because I conscientiously believe that the subject to which I am about to call your attention this evening has important bearings in all these directions, that I have determined to lay it before the members of this admirable Institution, convinced that nowhere could I find an audience more capable of understanding the great practical importance of the inquiry, or more interested in its right solution.

I had not been long in the position I have the honour to fill in the public service, before I became profoundly impressed with the vast losses sustained by the prevalence in the army of consumption and diseases of the circulatory system, that is, of the heart and great vessels. Within the last three years, excluding those who die in regimental and depôt hospitals, and those of the Household troops (I exclude all invalided in Ireland, of whom we at Netley see nothing), no less than 1,344 men have been lost to the service from consumption alone. Now the causes in operation tending to produce this enormous and costly loss are many and complicated.* That the present accoutrements and knapsack, interfering as they do with the free play of the important organs within the chest, exert an important influence in this direction, I do not doubt; but as the proof of this would lead me into details, and involve many points of inquiry not suited for discussion here, I shall not go further into it on this occasion, but will direct your attention to another source of inefficiency, which can be more directly traced to the *mischievous constriction* to which we subject the chests of our soldiers at the time we demand from them the *maximum of exertion*.

Between the 1st of July, 1860, and the 30th of June, 1861, 2,769

* A very general impression prevails that the recommendations of the Royal Sanitary Commissioners as regards the amount of cubic and superficial feet per man in barracks has been universally carried out. This, however, is far from being the case. The home regulation is 600 cubic and about 60 superficial feet per man, but even this *minimum* is rarely enjoyed by the soldier.

In Chatham the average cubic space is only 450. In hot Gibraltar the Barrack Commissioners report that no fewer than 3,617 men have under 450 cubic feet each, and 5,253 have less than 40 square feet each. While such a state of things exists, we cannot be said to have taken a single step to mitigate, much less remove, what is certainly the master sin of our whole system, viz., overcrowding in barracks.

According to General Morin, the reporter of the commission ordered to determine the ventilation of the Palais de Justice and the new theatres of Paris, as quoted by Dr. Parkes, to keep the air pure there must be supplied—

In barracks, by day, 1,060 cubic feet per head per hour.
" by night, 2,120 " " " —W.C.M.

men were discharged the service at Fort Pitt; of these 445 (or 16·07 per cent.) were under 2 years' service; and of these 445 discharges, *heart diseases* made up 13·7 per cent. From the 1st July, 1861, to 30th June, 1862, 4,087 men were discharged the service; 569 of them (or 13·92 per cent.) had less than 2 years' service, and of these, 14·76 per cent. were lost to the service from *heart diseases*.

From the date of my assuming charge of the medical division at Fort Pitt, in April, 1861, to the end of last year, no less than 883 cases of diseases of the circulatory system—in other words a number nearly equal to the strength of a battalion,—have passed under my observation, and been lost to the service, and this from one class of disease; the great bulk of the cases being young men returned to the civil population (that is, cast upon their parishes), and incapable of earning their bread in any active employment. The pension allowed to such short service men is but a pittance, and that pittance is granted only for a limited period. Let me remind you again, that in the figures I have given, the invalids of the Royal Artillery, the Guards, and the troops serving in Ireland, are not included; they were discharged without being seen by us at all.

Surely, gentlemen, you will agree with me, after hearing a statement so startling, that it behoves us to look narrowly into a question involving such an amount of suffering, costly invaliding, and inefficiency, with a view to the adoption of a remedial measure.

Before I address myself to an examination of the accoutrements and knapsack, and show the evils they induce, I must advert for a moment to three causes, which are supposed to exercise a disturbing influence on the organs of circulation, and to act either as predisposing or exciting causes of disease of the heart, viz., rheumatism, intemperance, and excessive smoking.

Rheumatism affects the fibrous structures of the frame; these structures enter into the formation of the delicate valves of the heart, and these valves are apt to suffer from this disease, to have their mechanism injured, and so to interfere prejudicially with the working of the heart—the central moving power. Now, many cases of heart disease can be traced to this cause, and soldiers, from the very nature of their calling, are of course much exposed to rheumatism; but, making a fair allowance for this, particularly among old soldiers, an immense number of cases remain that cannot be accounted for in this way. A vast number of the young soldiers discharged the service for heart disease have never suffered from rheumatism at all.

With regard to intemperance, it is undeniable that the presence of alcohol in the blood exercises a prejudicial influence on the heart and great vessels, as well as on other organs, but here we have the same difficulty to meet, viz., that a large proportion of our young lads are lost to the service from heart disease ere they have contracted the baneful habit of spirit drinking.

Nor do I deny that excessive abuse of tobacco may in many cases result in an irritable condition of the heart, incapacitating a man from much exertion; but I think there is no proof that young soldiers smoke more than other classes of the population.

Is it that soldiers are called upon to make greater exertions than the labouring and manufacturing classes? Doubtless the soldier has at drills, marches, and field-days to put forth considerable exertion; but is this more than, or so much, as we see daily done by our "navvies," and others of the labouring classes? I think not. We must look, then, to the different conditions under which the two classes work. A labouring man or mechanic, when he addresses himself to his work, lays aside every weight, and every article of dress that can in the slightest degree interfere with the free movement of his chest and limbs. In like manner, the sportsman, or the Alpine tourist, adapts his dress to the work in which he is engaged. But the soldier on the other hand, is called on to make the severest exertions, at the utmost possible disadvantage as regards the weight he has to carry, the mode in which he has to carry it, and the entire arrangement of his dress and equipment.

The function of respiration in health, when we are not unduly exerting ourselves, is carried on with so much ease and regularity, that we are hardly conscious of the action of its complicated mechanism; we draw air into our lungs and expel it without an effort. It is only when we experience in our own persons, or witness in others, the effects of even a momentary interruption to the due performance of this function, that we become aware of its vital importance to our very existence. Three minutes' total suspension of respiration, and we die. So essential is respiration to existence, that it is placed under the control and guidance of a part of the nervous system apart from the will, and it is only when the function is interfered with by disease or excessive exertion, that the assistance of muscles, under the direct control of that will, is called in to aid us in the struggle for the free admission of that air, without which we die. Let us glance for a moment at the chest and its contents.

I have here the framework of the torso or trunk. Within the elastic walls of the chest are placed the lungs, the heart, and the great vessels leading from it, and these fill it equally in all its alterations of size; it is so contrived, as to shield these vital parts from injury (save of course from injury of an extreme degree), and yet to give them that free play, without which their functions cannot be performed. You observe its construction—consisting of the spinal column behind, itself made up of many separate pieces, with an elastic fibro-cartilaginous cushion interposed between its separate parts, represented artificially here, the breast-bone in front, and the ribs, or osseous arches, enclosing the chest. Note that each rib has a cartilage of prolongation; these are of great strength, and very elastic. By their means, the seven true ribs are connected directly to the breast-bone, those of the remaining ribs, merely to each other. You cannot fail to observe that there is here unequivocal evidence of a provision for motion. Let us look now at the movements to which this anatomical arrangement points.

During inspiration, the collar bones, first ribs, and through them the breast-bone and all the annexed ribs, are raised; the upper ribs converge, the lower diverge, the upper cartilages form a right angle with the breast-bone, and the lower cartilages of opposite sides, from the seventh downwards, move further asunder, so as to widen the abdominal space between them, just below the point of the breast-bone; the effect being to raise, widen, and deepen the whole chest, to shorten the neck, and apparently to lengthen the abdomen. During expiration the position of the ribs and cartilages is reversed; the breast-bone and ribs descend, the upper ribs diverge, the lower converge; the upper cartilages form a more obtuse angle with the breast-bone, and the lower cartilages of opposite sides approximate, so as to narrow the abdominal space between them, just below the point of the breast-bone; the effect being to lower, narrow, and flatten the whole chest, to lengthen the neck, and apparently to shorten the abdomen. During inspiration, the movement of the lungs and heart is downward.*

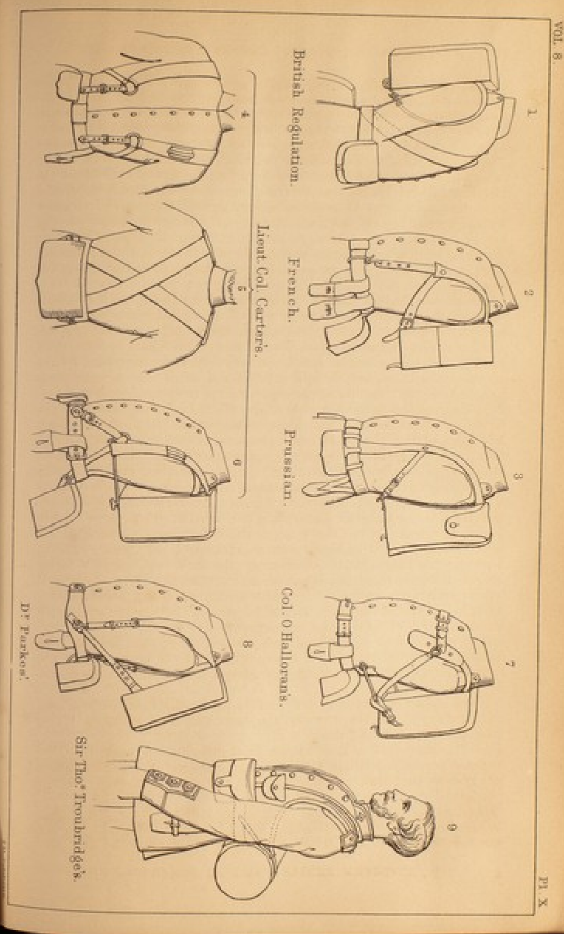
Let us now inquire whether there is anything in the mode in which the soldier is weighted and accoutred likely to interfere with these natural movements more or less at all times, and particularly when making severe exertion. And here I must take the opportunity of saying that this question has been very carefully examined by the professors of the Army Medical School; and, after mature consideration and inquiry into the whole question, we have arrived at the conclusion that the present accoutrements are highly injurious to the health of infantry soldiers, and have a large share in producing many affections of the lungs and heart common among them; in fact, so impressed have we been with the importance of the subject, that, in conjunction with Major Deshon, 2nd Depôt Battalion, an officer who has paid a great deal of attention to these points we made two reports on the pack and accoutrements of the infantry soldier, which reports were presented to the General commanding at Chatham. From these reports I shall quote largely in the course of the following observations. It will perhaps be well for me to mention that two great military nations, France and Prussia, have experienced the inconvenience of a faulty system of accoutrements to such an extent that they have introduced improvements intended to relieve the soldier from injurious pressure upon his chest and abdomen, and to interfere as little as possible with the free action of his muscles and organs.

The weight of the British soldier's clothes, great coat, field kit, and canteen, with 60 rounds of ammunition and 75 caps, havresack, bayonet, rifle, and sling, pack and straps, pouch, &c., &c., is 48 lbs. 5¼ ozs.

If the soldier has to carry his blanket, as in the field, with rations for three days, and his water-bottle, an addition of 12 lbs. is made, making in all 60 lbs. 5¼ ozs.

Let us now look a little closer at the regulation pack. In the diagram before you (Plate x., Fig. 1) is a drawing of it. You cannot fail to see that the whole weight of the pack is thrown on the

* Vide Sibson's Medical Anatomy.—Here Dr. Maclean showed a figure in outline, displaying the extent of these movements, and also a skeleton of the trunk, showing its framework, &c.—Ed.



straps passing under the arms; the pouch and a small packet for caps are carried on the belt, which runs diagonally across the chest, and the bayonet and ball-bag are carried on the waist-belt; the belts are therefore so disposed as to press most injuriously on the chest; the cross-belt, stretched by the great weight of the pouch, impedes the forward movement of the ribs; the waist-belt hinders the expansion of the inferior false ribs, which, as we have just seen, in the state of unrestricted movement, is very great; and the pack-straps press on important muscles, arteries, veins, and nerves to a degree which only those who have carried the loaded pack can appreciate. The weight, especially when the great coat is strapped on, falls to a great extent behind the line of the centre of gravity. Now these objections are by no means merely theoretical; soldiers universally complain of the sufferings they endure from the pack and present accoutrements, and if you closely question the sufferers from heart disease, you will find how closely they connect their complaints with these belts and packs.*

It is certain that at no period was the pack more worn that at present. I find that it is worn at least once a day on regimental parade, and on all brigade and field days at all the camps in this kingdom. I have been at some pains to ascertain from regimental medical officers the effects observed on the men, particularly on field days. Some do not appear to have paid much attention to the subject, but the majority seem alive to the ill effects of the pack and accoutrements.

Many men fall out in a state of extreme distress, and many surgeons assure me that nothing but a strong feeling of *esprit de corps* prevents many more from doing so. In all well-disciplined regiments the practice of falling out at drill or on the line of march is discouraged, and men will bear and suffer much, rather than incur the imputation of being "soft"—some, to my own knowledge, have worked on through a field day, and have died rather than give in. An instance of this occurred at Aldershot on a field-day last summer.

In the first of the reports on packs submitted for the consideration of the General commanding at Chatham, by the professors of the Army Medical School, the following were the general principles insisted on:—

1. To distribute the weight, as far as practicable, over the body.
2. To bring the weight, as far as possible, within the line of the centre of gravity.
3. To allow no pressure on the principal muscles, nerves, arteries, or veins.
4. To avoid most carefully all impediment to the fullest expansion of the lungs, and to the action of the heart.

This rule is a cardinal one. Unless the circulation through the lungs be quite free, continued exertion becomes impossible. The commonest experience shews that the number of respirations,

* Here the Professor showed a preparation of a human heart, taken from the body of a soldier, with a white spot or corn on it, which he explained arose from the pressure and friction to which the organ had been exposed. He further stated that this "corn," rare in civil life, is the rule and not the exception in the bodies of elderly soldiers.—ED.

and the amount of air drawn into and expelled from the lungs, is enormously increased by exertion. Late physiological inquiries have shown that the elimination of carbonic acid is also prodigiously augmented, and this is a necessary sequence of the muscular contraction. If this elimination be prevented by any interference with respiration, no amount of energy or volition on the part of the man will enable him to continue his exertion. Trainers, both of men and horses, have long been aware of this fact.

I have just shown you how impossible it is to carry out such principles as these with the regulation pack, which is constructed as if for the purpose of transgressing them all.

Fig. 2 shows the French pack, that worn by the Chasseurs de la Garde. It is secured by straps going under the arms, as in the English pack; but it is an improvement on the latter, as two straps run down from the arm-straps to the waist-belt, and so relieve in great measure that excessive pressure on the arms so much felt by our men. It approaches the Prussian pack, but is not so good; the pouch (which is small) is carried on the waist-belt behind, and there is no cross-belt whatever; the lungs have therefore very fair play with this pack, the amount of ammunition is, however, smaller.

Fig. 3 shows the Prussian pack and accoutrements. You see that they are arranged differently from any of the others. The ammunition is carried in two pouches attached to the waist-belt, capable of carrying each 20 rounds of English ammunition, and 15 of Prussian. The pack fits to the back, to which it lies as close as possible. Two broad straps pass from the top of the back over the shoulders and fall to the waist-belt, to which they are joined by two brass hooks.

Two other straps run from the lower part of the pack and join these shoulder-straps, so that the pack is quite steady, and its weight is counterbalanced by the pouches in front.

This pack is much superior to ours; it exerts only moderate pressure on the lungs, and none on any muscles or vessels; the weights are close to the body, and the weight of the pack falls within the centre of gravity. The arms have full play. In the trials conducted by us, this pack was invariably preferred by the men to our own, although it was not rated so highly as others.

Figs. 4 and 5, show front and back views of Lieutenant-Colonel Carter's accoutrements. Fig. 6, side view of accoutrements and pack. The pack is supported by two straps passing over the shoulders and hooking on to two iron rods, which project forward from the lower end of the pack; the front of the pack is concave, and is made of wicker work; its weight is very great, and it is altogether too large.

It is, however, a vast improvement on the regulation pack. It is borne on the shoulders, and does not press at all on the lungs, or upon any muscles, nerves, or vessels; the arms are quite free. The pouch, which is a large one, hangs away from the body too much. It is, however, carried easily. The belts are too heavy and complicated. In our trials the men reported favourably on this pack, all who tried it declaring it to be an immense improvement on the regulation pack.

The next is Berrington's pack, adapted with Colonel Spiller's rods by Colonel O'Halloran (Fig. 7). The belt represented in this drawing as passing across the chest is done away with in Colonel O'Halloran's improvement pack.

It is carried by means of two flexible steel plates lying in front of the chest, and having attached to them two straps passing from the lower end of the pack beneath the arms. Two rods, with a broad strap between them, support the lower part of the pack against the small of the back; no muscles or vessels are pressed upon, and the arms are perfectly free. The weights are tolerably close to the centre of gravity. With this pack, the pouch and bayonet are carried as in the regulation pack. The steel plates were thought by us an objection to this pack, as by their breadth they, in some degree, press on the ribs in inspiration. The pack, however, in our trials was favourably reported on.

A pack contrived by my colleague, Dr. Parkes (Fig. 8), was also tried. The principle of it is to throw the weight in part on the hips, by means of two straight iron rods running from the bottom of the pack, and fitting into two sockets in a hip-belt. The principle of this pack is sound, but there is great objection in this, as in the others, to the iron rods, which, if broken on service, cannot easily be replaced. They are also dangerous, for if struck in action the fragments would almost certainly be driven into the body of the wearer, or that of a comrade in the ranks. The conclusion come to by us, after a careful examination of all these packs, and carefully conducted trials with them all, was, that the regulation mode of carrying the pack was the worst of all; but good as some of the proposed plans are, none of them seem perfectly to answer all the required conditions.

Lieutenant-Colonel Carter and Colonel O'Halloran were not the only officers who saw the necessity of introducing a new and a better mode of carrying the pack.

Sir Thomas Troubridge exhibited at the last great Exhibition a valise, which I now show you (Fig. 9), and on which we (the professors) made a special report to Major-General Eyre, Commanding at Chatham, an officer who has taken a great interest in this question, and who gave us his cordial co-operation in investigating it.

This pack is carried in a mode different from any of the others. A yoke, on the principle of the milkmaid's yoke, is fixed on the shoulders; from this two metal rods (of tubular copper or of steel) pass down in front of the arm-pits, which they do not touch, and are hooked behind to a round bag or valise (without any frame), which is carried on the small of the back, or just above the hips. The weight of this valise is chiefly thrown on the shoulders, but it is also partly thrown on the strong hip-bones, in this resembling Dr. Parkes'. There is not the least pressure, either on the chest or on the arm-pits.

As the valise is thus carried so low down, the ammunition cannot be carried in a pouch behind. It is, therefore, placed in two pouches in front (each intended to carry thirty rounds), and a strap passes round the back of the neck, and hooks into each pouch.

A waist-belt carries the bayonet, and keeps the two pouches steady;

the pouches thus balance one another, instead of, as in the Prussian plan, the pouches balancing the pack.

The great-coat can be carried either on the top of the valise, or in a roll over the shoulder.

On considering the mode in which the weights are distributed on this plan, it is evident that it satisfies all the conditions which we formerly enumerated as essential to a perfect system.

Not the slightest pressure is made on the lungs; no great muscle, vessel, or nerve, is pressed upon; the weights are close to the centre of gravity, and are as near the line of the centre of gravity as they can be; while the strongest parts of the body, viz., the tops of the shoulders and the hip-bones, carry the weights.

As far as mechanical and physiological principles are concerned, we see nothing wanting in this plan. The weight, in pounds and ounces avoirdupois, of Sir Thomas Troubridge's valise, with kit, ammunition, &c., is 17 lbs. 12⅔ oz.

Any one who has seen the enormous weights carried by the Canton water-bearers, or the Banghy Burdars and palankeen-bearers of India, all borne on the shoulder, in such a way as not to interfere with the free play of the chest, will see that Sir Thomas Troubridge has thus hit on the right principle for carrying the soldier's pack and ammunition. We submitted this plan to a trial against O'Halloran's pack, as improved and exhibited in the last Great Exhibition.

Four experienced non-commissioned officers, and privates, after being carefully examined by me to see that they were free from chest disease, were marched eleven or twelve miles accompanied by Major Deshon, who closely watched them: they used the pack and valise alternately, and on returning, their unprompted statements were taken down by me verbatim. Without going into details, I may say that the reports of all the four men were identical: they all praised Colonel O'Halloran's pack, and thought it much better than the regulation, but they reported of the valise that it was as superior to Colonel O'Halloran's pack, as that was superior to the regulation.

The ease of breathing, the freedom of the arms, the apparent lightness of the weights, the absence of fatigue or exhaustion at the end of the march, with Sir T. Troubridge's accoutrements, were all points strongly insisted upon by these experienced non-commissioned officers and soldiers; nor did they hesitate to affirm that the efficiency of the soldier would be increased to an immense extent by their adoption throughout the service.

In conclusion, I trust that some of the distinguished officers present may be induced to inquire into this subject for themselves, to make comparative trials with the packs just exhibited, and with the contrivance of Sir Thomas Troubridge; if any can be induced to do so, and to investigate it thoroughly, I feel convinced they will find that my colleagues, and the gallant officers who have co-operated with us, have not exaggerated its importance. I am quite aware that the introduction of a new knapsack into the service would be a very costly measure; but if once the fact is established that the present knapsack is costly from the amount of invaliding it

entails, and cruel from the suffering it causes, enough will be done to warrant, at least, the gradual introduction of a better. To an audience such as this, I need hardly add, that the tendency of modern tactics, all over the world, is to rapid movements in the field, and if it is insisted on, that modern soldiers shall march and fight with their kit on their backs, it is obvious that this should be so placed, as to embarrass their movements to the smallest extent, if not they must fight and march at a grievous disadvantage.

The CHAIRMAN: I am sure Dr. Maclean will be ready to answer any question that any gentleman may wish to put, or should any gentleman wish to illustrate the subject by mentioning the results of his own experience, we shall be very glad to hear him. If no one has any observations to make, I am sure you will now join me in a vote of thanks to Dr. Maclean for the interesting lecture we have had, and for the able manner in which he has delivered it.

We will now proceed to call upon Dr. Domenichetti to begin his lecture.

PRINTED BY HARRISON AND SONS, ST. MARTIN'S LANE.

HOW PEOPLE MAY LIVE AND NOT DIE IN INDIA.

BY

FLORENCE NIGHTINGALE.

(A Paper read at the Meeting of the National Association for the Promotion of Social Science, Edinburgh, 1863. Reprinted by order of the Council, Aug., 1864.)

LONDON:
LONGMAN, GREEN, LONGMAN, ROBERTS, & GREEN.
1864.

LONDON:
EMILY FAITHFULL, PRINTER AND PUBLISHER IN ORDINARY TO HER MAJESTY,
VICTORIA PRESS, 83A, FARRINGDON STREET, E.C.

PREFACE.

THE REPORT of the Royal Commissioners on the sanitary condition of the Indian army was signed on May 19th, 1863. The following short abstract of some of the leading principles in that Report was read at the Edinburgh meeting of the Social Science Association held in October of the same year. It is now reprinted in consequence of many applications made for copies, on the ground that the paper had been found useful for soldiers and others interested in the Indian health question. Since the inquiry of the Royal Commission was begun, several great measures advocated in the Report and urged in the following pages, have been carried out. A Commission of Health has been appointed for each Presidency. And one of these Commissions, that for Bengal, has given public evidence of the zeal with which it has entered on its work. These authorities have been put into communication with the Barrack and Hospital Improvement Commission at the War Office, which now contains members representing the India Government. And by this time the India Commissions have been put in possession of all the more recent results of sanitary works and measures which have been of use at home.

The military authorities in India have also been actively engaged in improving the soldier's condition. And several of the worst personal causes of ill-health to which the soldier was in former times exposed have been or are being removed. The introduction of soldiers' gardens, trades, and workshops, which was begun in India a number of years since, has seen its happy results. The men have begun to find out that it is better to work than to sleep and to drink, even during the heat of the day.

One regiment marching into a station, where cholera had been raging for two years, were "chaffed" by the regiments marching out, and told they would never come out of it alive. The men of the entering battalion answered, they would see; we *won't* have cholera, they think. And they made gardens with such good effect that they had the pleasure, not only of eating their own vegetables, but of being paid for them too by the Commissariat. And this in a soil which no regiment had been able to cultivate before. And not a man had cholera. These good soldiers fought against disease, too, by workshops and gymnasia.

At a few hill stations the men have covered the whole hill-sides with their gardens.

Government gives prizes to the best gardeners. And means of employment and occupation for the troops are being everywhere extended.

As for trades, I have seen the balance-sheets of 32 battalions of infantry, and of five regiments of cavalry in Bengal, for six months ending June, 1863; and these brave fellows are actually making money. The wages paid to men for working in the half-year were £28,237.

The balance from preceding half-year .	£3,203
Amount realised for work last six months	55,426
Value of stock on hand . . .	17,216
	£75,845

That this money goes not to canteen or bazaar is shown by the savings banks. One battalion returning to England took £7,000 with it in its savings bank. Of 26 other infantry regiments, none had less than £3,000, nine had £4,000, five had £5,000 and up to £6,000 in theirs.

But want of accommodation in barracks for workshops has, alas, fettered this great progress.

At gymnastics the men get strength to bear the heat, though Highland regiments cannot quite rival themselves at games in the Highlands. The men are paraded for gymnastics at first, but like the exercise so much that they continue it of their own accords. Again, however, want of cover for gymnasia in barracks puts a stop to what otherwise might be done.

Cricket is general; fives, single-stick, and other manly games are common.

In short, work and all kinds of exercise cause sickly men to flourish. One regiment, sick of scurvy, and not recovering even at one of the healthiest stations, was cured by working at a mountain road in the rains, with only temporary huts for shelter.

Soldiers' libraries are everywhere supplied by Government. Bengal regiments generally manage to have some kind of reading-room; but reading-rooms specially constructed for their object are few.

Better cook-houses, cleaner cooking, are being introduced; and soldiers are taught to cook.

In the mean time, the regulation two drams have been reduced to one. The one dram is to be diluted with water. A Legislative Act imposes a heavy fine or imprisonment on the illicit sale of spirits near cantonments. Government supplies good beer, and plenty of it. Where there *are* recreation rooms, refreshments (prices all marked) are spread on a nice clean table. This the men like very much. And decrease in drink may be very much attributed to increase of useful work and of play, as the Commander-in-Chief in India himself says.

The practical result of these reforms is, then, that the soldier's time is more profitably occupied than formerly—and that intemperance and crime have visibly diminished.

So far for the soldier's habits.

But the main causes of disease in India, want of drainage, want of water-supply, for stations and towns, want of proper barracks and hospitals, remain as before in all their primitive perfection. Of this there is no doubt.

The above-mentioned improvements have removed several of the causes of disease enumerated in the Report of the Royal Commission. And they have also, happily, taken away some of the point in this paper.

Nevertheless it has been thought best to reprint it as read, because there are stations where little or nothing has been done in improving the soldier's habits, and because the great work of civilization in India has yet to be begun. It is moreover to be feared that little amendment has taken place in the self-indulgent eating and drinking habits of the European population generally.

While thankfully acknowledging the excellent beginning made, since the advent to power of the present noble Governor-General of India, enough remains to justify this reprint.

F. N.

August, 1864.

HOW PEOPLE MAY LIVE

AND

NOT DIE IN INDIA.

A Meeting of the Social Science Association is surely the place to discuss one of the most important of social questions, viz., how the British race is to hold possession of India; and to bestow upon its vast populations the benefit of a higher civilisation.

The first part of the question is for the present the most important. For, if it be impossible to keep possession of the country, there is an end of the problem.

The Royal Commission on the sanitary state of the army in India, whose two folio volumes of report and appendix constitute a new social starting point for Indian civilisation—has shown that, unless the health of British troops in India can be improved, and the enormous death-rate reduced, this country will never be able to hold India with a British army.*

* This report, unlike other reports, was based on two kinds of evidence;—1. The usual oral evidence of witnesses: 2. Reports from every station in India, in answer to printed questions sent out, the answers being signed by the commanding officer, the engineer officer, and the medical officer of each station.

It was truly said that such a complete picture of the life in India, both British and native, is contained in no other book in existence.

The time has not yet arrived for the pressure of the death-rate it discloses to be fully experienced, because the present large army is comparatively new to the country. But, unless active measures are taken by the India Government and by the military authorities to give effect to the recommendations of the Commission, it is unhappily certain that the mortality will increase with the length of service. And then will be felt the difficulty stated by Sir Alexander Tulloch, viz., of filling up the ranks of those, prematurely slain by preventible disease, from the recruiting depôts at home. Few men have had so much experience in this department of the Service. And he tells us that he very much doubts whether an army of seventy thousand men can be kept up in India, with the present death-rate.

In former times, when the company's troops bore but a small proportion to the resources (in men) of this country, the death-rate was not so much felt. The small army was swept away; and its place supplied, as often as necessary, from the recruiting offices at home. But, now that a large proportion of the whole British army is stationed in India, the question whether we shall hold or lose India will depend very much on the steps taken to protect it from disease.

The statement that the average death-rate of troops, serving in India, was no less than 69 per 1,000 per annum, took the country by surprise.

The accuracy of the average could not be denied. Because the statement was made on the authority of Sir Alexander Tulloch, and confirmed by a separate inquiry made with the help of the Registrar-General's Office, at the request of the Commission.

But it was endeavoured to explain away the obvious result of the figures, by showing that the average was not constant—that, in certain years and groups of years, the death-rate was much greater than in others; that the mortality in the years of excess was due to wars or other causes; that peace, and not sanitary measures, was therefore the remedy. And, in short, that the statement of a death-rate, averaging 69 per 1,000 per annum, was not a fair representation of the case.

To this there is the simple reply that, during this present century, there has been an average loss, from death alone, of 69 men out of every 1,000 per annum—it matters not how the mortality has been distributed—that there is every reason to believe that, if things go on as they have done in this present century, we shall go on losing our troops at the rate of 30, 50, 70, 90, 100 and upwards, per 1,000. And all the arithmetic in the world cannot conceal the fact that the law, by which men perish in India under existing sanitary negligence, is 69 per 1,000 per annum; this death-rate is, in fact, understated, for it says nothing of the invalids sent home from India who die at sea, or within a short time of their arrival at home; nor of the loss to the service by destroyed health ; nor of the mutiny years. It takes into account only those who die in India, and in the ordinary course of service.

Few people have an idea of what a death-rate of 69 per 1,000 represents—the amount of inefficiency from sickness—of invaliding.

Assuming the strength of the Indian army at 73,000 British troops—and taking the death-rate at present alone, without the sickness and invaliding—such an army, with this present death-rate, will lose, on an average of years, an entire brigade of 5,037 men per annum. It may lose, some years, half that number. But, in other years, it will lose two such brigades.

And where are we to find 10,000 recruits to fill up the gap of deaths of a single unhealthy year ?

It is said that the death-rates of the war-years being the highest (not from wounds), peace, and not sanitary measures, is the remedy. As well might it be said that the British army, having nearly perished before Sevastopol, not from wounds, but from want of every supply of civilised life, peace, and not the supply of the wants of civilised life, was the remedy.

The Royal Commission has shown that, if the death-rate were reduced to even twenty per thousand per annum (which is too high), *i.e.*, double that of home stations since these stations were improved, —to India would be saved a tax equal to £1,000 sterling per diem ; and this represents the mere cost

of replacing the men cut off by excess of premature and preventible mortality.

1. Unofficial people are everywhere asking the question, how this great death-rate has arisen—how it happens that one of the most civilised and healthy nations in the world no sooner lands the pick of its working population in tropical climates (for similar losses occur in all tropical climates among us) than they begin to die off at this enormous rate.

I am afraid the reply must be, that British civilisation is insular and local, and that it takes small account of how the world goes on out of its own island. There is a certain aptitude amongst other nations which enables them to adapt themselves, more or less, to foreign climates and countries. But, wherever you place your Briton, you may feel quite satisfied that he will care nothing about climates.

If he has been a large eater and a hard drinker at home—ten to one he will be, to say the least of it, as large an eater and as hard a drinker in the burning plains of Hindostan. Enlist an Irish or a Scotch labourer who has done many a hard day's work, almost entirely on farinaceous or vegetable diet, with an occasional dose of whiskey,—place him at some Indian station where the thermometer ranges at between 90° and 100°, and he will make no difficulty in disposing of three or four times the quantity of animal food he ever ate under the hardest labour during winters at home—if, indeed, he ever ate any at all.

Now the ordinary system of dieting British soldiers in India is more adapted to a cold climate than that of out-door farm servants doing work in England.

More than this, the occasional dram at home is commuted, by regulation, in India into a permission to drink two drams, *i.e.*, 6 oz. of raw spirits every day. And be it remembered that, at the same time, the men have little or nothing to do. The craving for spirits, induced by this regulation habit of tippling, leads to increase of drunkenness—so that, what with over-eating, over-drinking, total idleness, and vice springing directly from these, the British soldier in India has small chance indeed of coping with the climate, so-called. The regulation-allowance of raw spirit which a man may obtain at the canteen is no less than 18½ gallons per annum ; which is, I believe, three times the amount per individual which has raised Scotland, in the estimation of economists, to the rank of being the most spirit-consuming nation in Europe. Of late years, malt liquor has been partly substituted for spirits. But, up to the present time, every man, if he thinks fit, may draw his 18½ gallons a year of spirits, besides what he gets surreptitiously at the Bazaar.*

* Tippling is unfortunately not confined to common soldiers. Officers also use spirits, generally brandy with water or with soda-water. It relieves exhaustion for the time at the expense of the constitution, and is a prime agent in sending officers to the hills to recover their health, and home on sick furlough. The practice is at some stations called "pegging," alluding to putting pegs in one's coffin. Is not this practice of "pegging" one reason why officers are less healthy in India than civilians?

So much for intemperance. But not to this alone, nor to this mainly, nor to this and its kindred vice together, is to be laid the soldier mortality in India.

The diseases from which the soldier mainly suffers there are miasmatic : now intemperance never produced miasmatic diseases yet. They are foul-air diseases and foul-water diseases : fevers, dysenteries, and so on. But intemperance may cause liver disease ; and it may put the man into a state of health which prevents him from resisting miasmatic causes.

2. What are these causes ? We have not far to look.

The Briton leaves his national civilisation behind him, and brings his personal vices with him.

At home there have been great improvements everywhere in agricultural and in town drainage, and in providing plentiful and pure water supplies.

There is nothing of the kind in India. There is no drainage either in town or in country. There is not a single station drained. If such a state of things existed at home, we should know that we have fevers, cholera, and epidemics to expect. But hitherto only a few enlightened people have expected anything of the kind from these same causes in India (although they are always happening).

As regards water, there is certainly not a single barrack in India, which is supplied, in our sense of the term, at all. There are neither water-pipes nor drain-pipes. Water is to be had either from tanks, into which all the filth on the neighbouring surface may at any time be washed by the rains; or from shallow wells, dug in unwholesome or doubtful soil. So simple a piece of mechanism as a pump is unknown. Water is drawn in skins, carried in skins on the backs of men or bullocks, and poured into any sort of vessels in the barracks for use. The quantity of water is utterly insufficient for health, and as to the quality, the less said about that, the better. There is no reason to hope that any station has what in this country would be called a pure water supply. And at some it is to be feared that, when men drink water, they drink cholera with it.

The construction of barracks, where men have to pass their whole period of service, is another illustration of how completely home civilisation is reversed in India. All our best soldiers have been brought up in country cottages. And when in barracks at home, there are rarely more than from twelve to twenty men in a room. But as soon as the soldier comes to India he is put into a room with 100, or 300, and, in one case, with as many as 600 men. Just when the principle of sub-division into a number of detached barracks becomes of, literally, vital importance, the proceeding is reversed. And the men are crowded together under circumstances certain, even in England, to destroy their health.

To take another illustration:—Our home British population is about the most active in the world. In fact we in this country consider exercise and

health inseparable; but as soon as the same men go to India, they are shut up all day in their hot, close barrack-rooms, where they also eat and sleep; they are not allowed to take exercise; all their meals are eaten in the hottest part of the day, and served to them by native servants; and they lie on their beds idle and partly sleeping till sunset! "Unrefreshing day-sleep" is indeed alleged as one of the causes for the soldier's ill-health in India—the soldier, the type of endurance and activity, who now becomes the type of sloth!

3. The Indian social state of the British soldier is not only the reverse of the social state of the soldier at home, and of the class from which he is taken, but there is a great exaggeration in the wrong direction. Yet people are surprised that British soldiers die in India; and they lay the whole blame on the climate.

It is natural to us to seek a scapegoat for every neglect, and climate has been made to play this part ever since we set foot in India. Sir Charles Napier says, "That every evil from which British troops have suffered has been laid at its door." "The effects of man's imprudence are attributed to climate; if a man gets drunk, the sun has given him a headache, and so on." In regard to Delhi, he says, "Every garden, if not kept clean, becomes a morass; weeds flourish, filth runs riot and the grandest city in India has the name of being insalubrious, although there is nothing evil about it that does not appear to be of man's own creation."

One most important result of the inquiry of the Royal Commission has been to destroy this bugbear. They have reduced "climate" to its proper dimensions and influence, and they have shown that, just as hot moist weather at home calls people to account for sanitary neglects and acts of intemperance, so does the climate of India call to account the same people there. There is not a shadow of proof that India was created to be the grave of the British race. The evidence, on the contrary, is rather in the other direction, and shows that all that the climate requires is that men shall adapt their social habits and customs to it; as, indeed, they must do to the requirements of every other climate under heaven.

This necessity includes all the recommendations made by the Royal Commission for improving the health, and reducing to one-sixth the death-rate of the British army in India. They all amount to this :—You have in India such and such a climate; if you wish to keep your health in it :—

Be moderate in eating and drinking; eat very little animal food; let your diet be chiefly farinaceous and vegetable.

Spirits are a poison, to be used only (like other poisons) for any good purpose, under medical advice.

Use beer or light wine, but sparingly.

Drink coffee or tea.

Clothe yourself lightly to suit the climate, wearing thin flannel always next the skin.

Take plenty of exercise, and use prudence and common sense as to the times of it.

So far for personal habits. But a man cannot drain and sewer his own city, nor lay a water supply on to his own station, nor build his own barracks. What follows pertains to Government :—

Let it be the first care to have a plentiful supply of pure water laid on for every purpose.

Drain all dwellings.

Have no cess-pits.

Attend rigidly to cleansing, not only to surface-cleansing.

Never build in a wet hollow nor on a sludgy river-bank, which would be avoided by sensible people even at home.

Never crowd large numbers into the same room.

Build separate barrack-rooms, instead of large barracks.

Place these so that the air plays freely round them.

Raise them above the ground with a current of air beneath.

Do these things, and the climate may be let to take care of itself.

But, if we would make India about as healthy as England, only somewhat hotter, let us have improved agriculture and agricultural drainage.

If all these improvements were carried out, the normal death-rate of the British soldier would be not 69 per 1,000, but 10 per 1,000, say the Commissioners.

But it is not for the soldier alone we speak. The report has a much deeper meaning and intent than this :—it aims at nothing less than to bring the appliances of a higher civilisation to the natives of India. Such revelations are made, especially in the reports from the stations, with regard to the sanitary condition of these, as to be almost incredible. Everywhere the people are suffering from epidemic diseases ; fevers, dysenteries, cholera—constant epidemics we may call them, and constant high death-rates (how high can never be known, because there is no registration).

The plague and pestilence is the ordinary state of things. The extraordinary is when these sweep over large tracts, gathering strength in their course, to pass over gigantic mountain ranges and to spread their ravages over Western Asia and Europe. And all this might be saved !

We know the causes of epidemic outbreaks here. Take the worst condition of the worst and most neglected town district at home ; and this is, to say the least of it, much better than the normal condition of nearly the whole surface of every city and town in India.

Not one city or town is drained.

Domestic filth round the people's houses is beyond description.

Water-supply is from wells, or tanks, in ground saturated with filth.

No domestic conveniences.

Every spare plot of ground is therefore in a condition defying us to mention it farther.

Rains of the rainy season wash the filth of the past dry season into the wells and tanks.

The air in, and for some distance round, native towns is as foul as sewer air. [At Madras a wall has actually been built to keep this from the British town.]

No sanitary administration. No sanitary police.

Here then we have, upon a gigantic scale, the very conditions which invariably precede epidemics at home. India is the focus of epidemics. Had India not been such, cholera might never have been. Even now, the Sunderbunds, where every sanitary evil is to be found in its perfection, are nursing a form of plague increasing yearly in intensity, covering a larger and larger area, and drawing slowly round the capital of India itself.

Are we to learn our lesson in time ?

Some say :—What have we to do with the natives or their habits ?

Others find an excuse for doing nothing in the questions arising out of caste. But caste has not interfered with railways.

The people of themselves have no power to prevent or remove these evils—which now stand as an impassable barrier against all progress. Government is everything in India.

The time has gone past when India was considered a mere appanage of British commerce. In holding India, we must be able to show the moral right of our tenure. Much is being done, no doubt, to improve the country—by railways, canals, and means of communication ; to improve the people—by education, including under this word, European literature and science.

But what at home can be done in education, if we neglect physical laws ? How does education progress here, without means of cleanliness, of decency, or health ? The school lessons of a month are sapped in an hour. If the people are left a prey to epidemics and to immoral agencies in their homes, it is not much good sending them to school. Where should we be now with all our schools, if London were like Calcutta, Madras, or Bombay ?—the three seats of Government in India.

The next great work then is sanitary reform in India.

There is not a town which does not want—

Water-supply.

Draining.

Paving.

Cleansing.

Healthy plans for arranging and constructing buildings.

Together with agricultural drainage and improved cultivation all round.

These things the people cannot do for themselves. But the India Government can do them. And, in order to do them, three Health Departments (one for each of the Presidencies) have been recommended by the Royal Commission, together with a Home Commission to help these Departments in bringing the appliances of a better civilisation to India.

The work is urgent. Every day it is left undone adds its quota of inefficiency to the British Army, and its thousands of deaths to the native population. Danger is common to European and to native. Many of the best men this country ever had have fallen victims to the same causes of disease which have decimated the population of Hindostan. And so it will be till the India Government has fulfilled its vast responsibility towards those great multitudes who are no longer strangers and foreigners, but as much the subjects of our beloved Queen as any one of us.

The real, the main point in the Report of the Royal Commission is this :

Look to the state of your stations first—then look to the hills for help. Your stations and cities are in a condition which, in the finest temperate climate in Europe, would be—have been—the cause of the Great Plague—of half the population being swept off by disease. And on the other hand, no climate in the world, certainly not that of India, could kill us, if we did not kill ourselves by our neglects. We complain of the climate, when the wonder is that there is one of us left, under a sky which certainly intensifies causes of disease—so much so indeed that, one would have thought, it might set men to work to remove these causes, and twice as vigorously as in a temperate climate, instead of not at all.

But no : our cities are not those of civilised men.

It cannot now be said, as Burke did : "England has built no bridges, made no high roads, cut no navigations." But in all that regards the social improvement of cities, still it must be said, as he did—how many years ago ?—"Were we driven out of India this day, nothing would remain to tell that it had been possessed, during the inglorious period of our dominion, by anything better than the ourang-outang, or the tiger."

For how much is it better now ?

Bring your cities and stations within the pale of civilisation. As they are, they are the life destroyers, not the climate.

The hills, those very climates to which you look for succour, are becoming so pestiferous from your neglects, that they bear out this indictment. They cry to you as we do : reform your stations—thence comes the deadly influence.

The question is no less an one than this :—How to create a public health department for India—how to bring a higher civilisation into India. What a work, what a noble task for a Government—no "inglorious period of our dominion" that, but a most glorious one !

That would be creating India anew. For God

places His own power, His own life-giving laws in the hands of man. He permits man to create mankind by those laws—even as He permits man to destroy mankind by neglect of those laws.

POSTSCRIPT.

Since this Paper was read, the lower death-rate of troops new to the country has actually been put forward as a proof that India is becoming healthy, and the 69 per 1,000 is an old antiquated average ! But more than this, the diminution of mortality arising from the short duration of service, is ascribed to improvements carried out at Indian stations since the Royal Commissioners began their inquiry. The leading authorities on the subject ascribe the main causes of disease to want of drainage—bad sites—bad water badly distributed—wretched sanitary condition of native bazaars and towns—bad barrack and bad hospital construction—surface over-crowding from want of barrack accommodation—want of occupation for the men—intemperance in eating and drinking — want of proper barrack and hospital conveniences ; it is difficult to see how India could have been freed from these causes of disease in three short years, which is about the average time since the Stational Reports were signed.

That something may have been done in the way of cleansing, ventilation, ablution, arrangements, means of recreation, is possible.

But as to ventilation, it may almost be said that it is better to keep the foul air out than to let it in, at least at certain stations of which we have reports up to nearly the latest date from India.

As to cleansing we have the report of a Government Commission on the last cholera, dated July 21, 1862, which tells us that, at a large station where cholera was fatal, the filth from the latrines was thrown down at places 100 yards from the barracks —that dead animals and every kind of refuse are accumulated in the same places without burial— that, before the cholera appeared, there were abominable cess-pools poisoning the whole atmosphere— that neglect of the commonest principles of sanitary science favoured the epidemic,—that the filth from the native latrines was used for feeding sheep!— that, for all this, the local military authorities had not neglected "conservancy in any unusual degree," the reporters state—and that, bad as they considered it, the station was kept in much better order than many that they had visited.

We have also two printed documents of the Public Works Department, dated Calcutta, June 26, and September 9, 1863, proving that the capital of India was in a much worse state than appeared from the Stational Report sent to the Royal Commission in June, 1860.

DISCUSSION

SUR

L'HYGIÈNE DES HOPITAUX

DISCOURS

PRONONCÉ

A LA SOCIÉTÉ DE CHIRURGIE

DANS LA SÉANCE DU 23 NOVEMBRE 1864

PAR

M. Hte Bon LARREY.

PARIS

TYPOGRAPHIE DE HENRI PLON,

IMPRIMEUR DE L'EMPEREUR,

RUE GARANCIÈRE, 8.

1864

DISCUSSION

SUR

L'HYGIÈNE DES HOPITAUX.

Messieurs,

La discussion de la Société de chirurgie sur l'hygiène des hôpitaux applicable à la reconstruction de l'Hôtel-Dieu, m'avait paru jusqu'ici appartenir beaucoup plus à la pratique civile qu'à la pratique militaire, et je me serais peut-être abstenu d'y prendre part, si je n'y avais été entraîné définitivement par le discours de M. Gosselin. J'ai été surpris, je l'avoue, de ses opinions contraires à la pensée générale de la Société; mais si la position même de notre honorable collègue donne une grande autorité à sa parole, la loyauté de son caractère lui fera regretter l'expression de ses doutes, de ses incertitudes sur quelques-uns des points les plus essentiels de l'hygiène hospitalière.

Voilà pourquoi, Messieurs, je me décide à intervenir dans la question, encouragé que j'y suis d'ailleurs par quelques-uns d'entre vous, et surtout par le digne promoteur de cette discussion.

Mon intention ne saurait être de reproduire devant la Société de chirurgie le long discours que j'ai prononcé, en 1862, à l'Académie de médecine, sur l'hygiène des hôpitaux militaires; mais je me propose d'emprunter aux grands établissements de l'armée quelques-uns des arguments les plus propres à établir la conviction sur ce qui convient le mieux à la salubrité des hôpitaux en général et à celle de l'Hôtel-Dieu en particulier. Une expérience de trente et quelques années dans les hôpitaux militaires, l'habitude de suivre pendant longtemps les hôpitaux civils, la suppléance de M. le professeur Cloquet pendant trois ans à l'hôpital des Cliniques, et enfin depuis 1858, l'inspection médicale de la plupart des hôpitaux militaires de la France et de l'Algérie, tels sont les antécédents que je puis faire valoir pour discuter la question qui occupe en ce moment l'attention du corps médical et qui semble suspendre encore l'exécution d'un projet officiel.

Cependant, Messieurs, cette question est à la fois si vaste et si complexe, que je ne saurais en séparer les principaux éléments. Je vous demande donc la permission d'apprécier, à mon point de vue, ce qui a été ou pouvait être dit par plusieurs de nos collègues, et d'y joindre quelques considérations empruntées aux hôpitaux de l'armée, pour en faire l'application au futur hôpital civil.

L'étude critique de M. Trélat sur la reconstruction de l'Hôtel-Dieu expose si nettement l'état de la question et en déduit si bien les conséquences, qu'elle a déjà fixé l'attention de l'autorité administrative, comme elle doit, malgré quelques dissidences, éclairer nos débats.

Mais n'oublions point les efforts persévérants, accomplis de nos jours, par l'Assistance publique, pour assainir et transformer les hôpitaux, depuis les mémorables rapports de Tenon et de Bailly, jusqu'au magnifique travail de M. Husson, qui résume largement tout ce qui a été dit, tout ce qui a été fait, à cet égard, tant à l'étranger qu'en France. N'oublions pas non plus l'intervention si utile de plusieurs de nos honorables collègues dans la commission médicale qui a été saisie de l'examen de cette importante question. Le projet nouveau de reconstruction de l'Hôtel-Dieu a été de sa part l'objet d'un important rapport fait par M. Broca, avec une appréciation impartiale des vues de l'administration et des intérêts de l'hygiène.

Toutefois, malgré les concessions déjà obtenues, ou à obtenir encore, il n'en reste pas moins dans l'ancien Hôtel-Dieu toujours occupé, un effectif de 800 lits dont il faudra bien rétablir l'équilibre pour les besoins du service hospitalier. C'est là que réside le point de départ de la reconstruction projetée, ne le perdons pas de vue, en tenant même compte de la réduction consentie à 600 lits, réduction qui pourra s'effectuer plus complétement aussi par une répartition nouvelle ou différente et déjà proposée de cet effectif nécessaire.

Que convient-il donc de faire, selon nous, dans ce but définitif?

C'est d'abord, Messieurs, de prévenir à tout prix l'encombrement, qu'il faut considérer comme le fléau du régime hospitalier, et dont les conséquences deviennent désastreuses, lorsqu'elles sont méconnues, quelles que soient d'ailleurs les autres conditions d'hygiène les meilleures et les mieux comprises.

Je croirais superflu de revenir et d'insister sur cette considération fondamentale, si elle n'échappait ordinairement à l'attention ou aux souvenirs des gardiens de la santé publique. Il suffit en effet que la constitution médicale régnante multiplie les maladies, même les plus

légères, et à plus forte raison, provoque le développement des épidémies les plus graves, pour qu'aussitôt la répartition des malades dans les hôpitaux en dépasse le mouvement habituel. Il y a là, ou plutôt il y a eu, à certaines époques, une tendance, je n'ose dire une routine traditionnelle, aussi bien militaire que civile, inspirée sans doute par l'intention du bien, mais préjudiciable à la salubrité, c'est l'accumulation des malades dans les salles. Les preuves à l'appui seraient sans nombre, s'il était opportun de les rechercher, et l'un des exemples les plus frappants déjà cités, c'est le cadre primitif de l'hôpital Lariboisière qui ne devait comprendre que 400 malades, mais qui en a reçu 600. De là, probablement, cette destinée fatale, malgré les conditions les plus heureuses, à tant d'autres égards. Et combien d'autres hôpitaux ne pourrait-on pas citer qui ont subi ces conséquences fâcheuses d'une augmentation de leur effectif normal !

Il n'est pas besoin d'ailleurs d'emprunter seulement aux grandes réunions de malades des exemples à l'appui de cette vérité, pour faire ressortir les dangers de l'encombrement. Il nous suffira de vous dire que dans l'armée les casernes s'infectent comme les hôpitaux. Pringle et bien d'autres hygiénistes militaires l'ont démontré. C'est ainsi que la caserne Napoléon a offert, à l'origine de son installation, un état d'insalubrité qui a disparu par la diminution des troupes. C'est encore ainsi que la caserne monumentale du Prince-Eugène, sur le boulevard du Temple, était devenue un foyer morbide, dont se ressentait surtout l'hôpital Saint-Martin, par l'affluence des malades. Une commission spéciale s'est activement préoccupée de cette situation, et après bien des recherches, après certaines hésitations, elle a conclu à faire évacuer définitivement tout un bataillon de cette caserne, qui désormais est devenue salubre.

De semblables faits sont multipliés, presque forcément, à bord des navires, et nos dévoués confrères les chirurgiens de la marine pourraient en fournir bien des exemples applicables pour eux à un vaisseau-hôpital, comme l'est pour nous la question générale d'hygiène appliquée à la reconstruction de l'Hôtel-Dieu.

La conséquence logique et très-simple de ce fait fondamental, c'est donc d'éviter l'accumulation des malades, et de leur assurer le plus d'espace possible aux dépens, si on veut, de l'élégance, des embellissements et du luxe inutiles aux établissements hospitaliers.

Ne doutons pas que l'administration municipale, si bien dirigée, ne veuille et ne sache appliquer à l'Hôtel-Dieu l'œuvre d'assainissement qu'elle a déjà si largement accomplie, pour les divers établissements publics de Paris tout entier.

Cela dit, Messieurs, je reprendrai, selon mes vues, les points les plus essentiels de la question qui nous occupe. Et d'abord l'emplacement.

Le principe d'établir les hôpitaux *extra muros* est certainement rationnel, toutes les fois que les limites d'une ville ne sont ni trop étendues, ni fortifiées. C'est une situation très-favorable que j'ai été à même de constater, dans un grand nombre de localités où m'ont conduit en France mes devoirs d'inspection médicale. Il paraît que hors des murs, devraient être surtout placés les hôpitaux d'accouchement, reconnus insalubres au contraire dans l'intérieur des villes.

Mais il n'en serait plus ainsi pour les grandes cités, où la distance à parcourir étant trop considérable et les besoins de l'assistance publique trop multipliés, nécessitent absolument des hôpitaux *intra muros*; et je m'étonne que l'on ait proposé de les transférer tous à la campagne. Les plus grandes villes de l'Europe ont des hôpitaux dans leur enceinte, comme on le voit à Londres surtout, dont l'organisation hospitalière a été si bien étudiée par MM. Le Fort, Giraldès, Blondel, et par d'autres encore.

La même nécessité subsiste pour les villes fortifiées, grandes ou petites, dont on ne saurait écarter les hôpitaux, sans franchir d'abord la distance voulue de la zone militaire et sans les exposer, en cas de guerre ou d'investissement, à devenir non-seulement des établissements inutiles, mais encore des lieux de refuge ou des postes de retranchement pour l'ennemi.

Reconnaissant toutefois que la situation de certains hôpitaux dans l'intérieur les expose davantage aux funestes effets de l'encombrement, je m'abstiens, tout exprès, d'en citer des exemples.

Un fait général m'a quelquefois paru inexplicable par les étranges vicissitudes que peut subir tel ou tel établissement. Soit une caserne, placée dans les conditions de salubrité les plus désirables et à peine occupée par un nombre de troupes au-dessous de sa contenance; mais cette caserne est neuve ou de récente construction et les hommes y tombent malades. Près de là se trouve une autre caserne dont le mauvais emplacement, le mauvais état, et l'occupation entière, représentent un foyer d'insalubrité apparente; il n'en est rien cependant, et nulle influence morbide ne s'y manifeste; mais cette caserne est vieille et vouée à la démolition, telle est, entre autres, la caserne de l'Ave Maria, près de celle des Célestins. Y aurait-il là cette influence des habitations particulières, reconnues insalubres, lorsqu'elles sont toutes neuves? Je le croirais volontiers. Ce serait donc un point à examiner et à sauvegarder pour l'occupation du futur Hôtel-Dieu.

Quoi qu'il en soit à cet égard, Messieurs, il deviendra utile d'examiner, un jour, si la répartition actuelle de tous les hôpitaux du nou-

veau Paris ne convient pas aux besoins de la grande cité, s'il n'y aura pas lieu d'en établir de nouveaux, et dans quels arrondissements il conviendra de les placer plus tard.

Nous pourrions désirer, avec quelques-uns de nos collègues, que le premier hôpital à créer fût situé au nord-est de la ville, où se porte aujourd'hui la plus grande masse de la population ouvrière, et je désignerais d'autant mieux le quartier Popincourt, que la place de Paris a eu là autrefois un grand hôpital militaire, destiné plus particulièrement aux vénériens de la garnison.

On ferait peut-être bien ensuite de construire un hôpital civil aux Batignolles; mais n'allons pas trop loin d'avance, et rapprochons-nous de l'Hôtel-Dieu.

Son emplacement actuel, depuis si longtemps critiqué, soumis tant de fois à des projets de reconstruction, soit sur place, soit ailleurs, a été, notamment de la part de M. Trélat, l'objet d'une appréciation rigoureuse qui me semble bien fondée. Je n'essayerai donc pas de la reproduire, mais nous devons faire à cet égard de sages réserves, en poursuivant d'abord l'examen des conditions applicables à l'Hôtel-Dieu.

S'il pouvait être reconstruit sur un lieu élevé, ce serait une situation assurément préférable à celle qu'il occupe encore, ou à celle qui lui est destinée; car on s'accorde à reconnaître les avantages de cette position pour les hôpitaux, et c'est ainsi qu'il en est souvent pour les hôpitaux de l'armée, soit en France, soit plus généralement en Algérie. Notons cependant qu'il y a des exceptions à cette règle. C'est ainsi que l'hôpital du Saint-Esprit à Rome, près du Vatican, passait autrefois pour très-insalubre, et m'a paru tel, quoiqu'il soit placé sur un point culminant de la ville.

Il n'en est pas moins vrai néanmoins que les lieux bas et humides, entourés d'eaux stagnantes, sont tout à fait contraires à l'emplacement d'un hôpital. Cette vérité n'a pas besoin de preuves.

Mais il ne faut pas confondre dans cette réprobation le voisinage des cours d'eau qui précisément semblent plutôt favorables que nuisibles à la salubrité de l'établissement. On ne saurait en douter pour les principaux hôpitaux de Lyon, placés sur les bords du Rhône, et on l'a constaté pour l'Hôtel-Dieu de Nantes, dont la reconstruction récente entre deux grands bras de la Loire avait été approuvée par une commission spéciale.

Il pourrait donc en être de même pour l'Hôtel-Dieu, faute d'un emplacement meilleur et à condition d'éloignement de cet hôpital du petit bras de la Seine, qui ressemble plus à une eau stagnante qu'à une eau courante.

Le plan de reconstruction de l'Hôtel-Dieu dans la Cité se rattache peut-être, Messieurs, à des considérations d'un ordre que nous ne pouvons apprécier, soit au point de vue de l'administration municipale, soit au point de vue de la topographie politique; mais, eu égard à la question d'hygiène, déjà si complexe et si difficile par elle-même, nous ne saurions point approuver cet emplacement, qui n'a plus sa raison d'être, comme autrefois, alors que toute la Cité représentait un amas d'habitations ouvrières ou pauvres, et lorsque les quartiers environnants, lieux malsains ou infectés, faisaient affluer chaque jour les malades à l'Hôtel-Dieu. Témoin cette rue même éloignée, dite de la Mortellerie, à cause de la funeste destinée de ses habitants.

N'insistons pas sur une vérité bien reconnue, en espérant toutefois que si le projet d'emplacement officiel est maintenu, il pourra être subordonné à des réductions désirables, comme garantie de sa salubrité. Il suffirait pour cela d'en former seulement un hôpital d'urgence ou de premiers secours, en lui donnant du reste toutes les proportions d'un modèle en ce genre, mais en lui assurant le plus vaste espace de terrain et toutes les autres conditions d'hygiène hospitalière.

Si, au contraire, le plan topographique était abandonné, pour la translation de l'Hôtel-Dieu dans le voisinage, je me rallierais complétement à la pensée de plusieurs de nos collègues, exprimée surtout et bien motivée par M. Trélat, c'est-à-dire de placer l'hôpital sur le terrain actuel de l'annexe.

Ici, Messieurs, se représente la question des grands et des petits hôpitaux. On conteste, en principe, aux grands hôpitaux, les conditions de salubrité, que, toutes choses égales d'ailleurs, les petits hôpitaux possèdent plus sûrement. Je partage cette opinion, qui pourrait, au besoin, se fonder sur ce que j'ai vu dans les établissements de l'armée. Il y a même eu autrefois, pour la garnison de Paris, de petits hôpitaux, oubliés aujourd'hui, et qui étaient alors des succursales du Val-de-Grâce : tels étaient les petits hôpitaux de la rue des Postes, de la rue Blanche et de Picpus, où, en 1832, j'ai partagé, avec mon collègue et ami M. Sédillot, un service spécial de cholériques. Mais si bien installés, si salubres que fussent ces petits hôpitaux, malgré leurs proportions restreintes, l'administration de la guerre dut les abandonner, parce qu'ils devenaient onéreux, exigeaient plus de moyens de transport et rendaient difficiles l'exécution, l'entretien ainsi que la surveillance du service.

Voilà, en effet, Messieurs, les inconvénients des petits hôpitaux, on ne peut le nier; mais on ne doit, en définitive, accorder la préférence aux grands hôpitaux, qu'à condition de les voir largement installés loin des habitations, à défaut de la campagne, c'est-à-dire au dehors ou aux confins des villes. Tel est l'hôpital de la Charité, à Berlin, le plus

magnifique modèle en ce genre; tels sont quelques-uns de nos plus beaux établissements civils et militaires de France.

Et encore faut-il, pour assurer l'hygiène des grands hôpitaux, pourvoir à leur distribution intérieure, avec une intelligente sollicitude pour le bien-être et les besoins des malades.

Je conclurai donc à l'utilité de maintenir les grands hôpitaux, avec toutes les améliorations désirables, en dehors des centres de population, et à la nécessité de n'établir au milieu des villes que de petits ou de moyens hôpitaux, proportionnés aux exigences d'un service bien dirigé, bien fait et préservé surtout de l'encombrement. C'est à ces conditions seulement qu'un petit hôpital pourrait être reconstruit, sans préjudice, dans la Cité, ou mieux encore dans son voisinage.

La construction d'un hôpital, évaluée à 15 ou 20 0/0 de la superficie totale du terrain d'emplacement, doit avoir ses proportions, d'après l'étendue et non d'après l'élévation du bâtiment ; on est bien d'accord aujourd'hui sur ce premier point.

Il n'en est pas ainsi de la forme de construction en elle-même, qui varie singulièrement, selon le goût des architectes ou des ingénieurs, et qui devrait pourtant s'adapter, avant tout, à la santé des malades. La forme rectangulaire d'un seul bâtiment, susceptible de s'étendre plus ou moins, me semble le système le meilleur, parce qu'il assure l'espace, l'air et la lumière de toutes parts, tandis que les autres formes, en croix, par exemple, comme dans beaucoup d'hôpitaux d'Italie et même de France, en T, en demi-cercle, et surtout en carré fermé, constituent plus ou moins des obstacles aux bienfaits de l'aération.

J'en dirais autant des pavillons séparés qui deviennent insalubres, si, n'étant point placés sur la même ligne, ils se trouvent trop rapprochés les uns des autres, ou rangés les uns devant les autres, se faisant ombre mutuellement, et se privant en partie réciproque des avantages mêmes que l'on cherche à leur assurer.

C'est pourquoi, Messieurs, l'orientation de l'hôpital n'est pas indifférente, comme on l'a supposé. La meilleure paraît être de l'est à l'ouest, à l'instar, par exemple, du palais des Tuileries et du palais de Versailles, préservés en été de la chaleur du soleil, et en hiver des vents du nord. Il serait donc désirable que cette exposition fût substituée pour l'Hôtel-Dieu à l'orientation projetée, toute contraire à celle-là.

L'élévation de l'édifice constitue l'un des points essentiels de la construction. Bailly et Tenon, les premiers, ont insisté judicieusement sur l'avantage des bâtiments à un seul étage, en accordant qu'il convient quelquefois d'en avoir deux, mais jamais trois pour les malades.

Les inconvénients de plusieurs étages superposés, s'infectant de bas en haut, ont été assez prouvés depuis, pour que nous n'ayons pas à y revenir aujourd'hui. Ce vice de construction tend à s'aggraver d'ailleurs d'autant plus, dans les bâtiments à quatre faces, fermées de toutes parts, comme les cloîtres, celui du Val-de-Grâce, par exemple. Il en est de même, par analogie, pour les hautes casernes complétement closes. Nous ne saurions trop réclamer à cet égard la sollicitude de l'autorité, afin de prévenir la décision d'une installation aussi défectueuse pour tout hôpital et spécialement pour l'Hôtel-Dieu.

Dans la distribution intérieure des locaux, les sous-sols, que l'on a raison de réprouver absolument, pour y loger des malades, ne seraient pas sans avantage, pour isoler le rez-de-chaussée d'un terrain humide, en assurant à l'édifice les conditions d'assainissement d'une construction bien faite aujourd'hui.

Au rez-de-chaussée, du reste exhaussé, seraient répartis les différents services de l'administration, la communauté des sœurs, et les dépendances de l'hôpital, pharmacie, cuisine, salle de garde, parloir, etc. L'étage supérieur appartiendrait exclusivement aux malades, et à la rigueur un second étage, laissé à peu près vide ou en réserve, servirait, selon le besoin, à disséminer les convalescents ou à isoler les malades graves.

Un double escalier, au milieu du bâtiment, séparerait le service des hommes de celui des femmes et des enfants, que l'on doit admettre aussi à l'Hôtel-Dieu, mais à part.

Quant à l'aspect extérieur de l'édifice, il doit être simple, sévère et digne de sa destination, sans comporter d'ornements superflus d'architecture. C'est à dessein que je me permets cette remarque, pour prévenir tout excédant de dépense inutile, alors qu'il faudrait au contraire viser à la plus intelligente économie de construction, afin de fonder, s'il est possible, deux hôpitaux plutôt qu'un seul.

Hors ces dispositions bien entendues, tout hôpital menacé d'encombrement serait plus insalubre, en temps d'épidémie, que les tentes et les baraques militaires ne le sont en campagne. Il y a même dans l'armée un hôpital entièrement baraqué, celui du Dey, à Alger, construit en 1830, comme hôpital provisoire, et resté assez sain jusqu'à présent, pour que sa vétusté seule le fasse remplacer aujourd'hui par un hôpital définitif.

La condition d'espace en largeur est donc la plus essentielle, pour répandre sur un hôpital l'air, la lumière et la chaleur dont il a besoin; car l'espace en hauteur seulement deviendrait plus nuisible qu'utile, comme je m'en suis assuré en Italie, pendant la campagne de 1859, lorsque quelques églises ont été provisoirement ouvertes à nos blessés.

Les moyens d'aération naturelle me semblent aussi de beaucoup préférables, en principe, aux systèmes les plus ingénieux de ventilation

artificielle. Ceux-ci néanmoins ne doivent pas être négligés pour seconder provisoirement ceux-là, plutôt que pour les remplacer définitivement, à moins de conditions exceptionnelles.

L'installation des salles a une telle importance, que l'on ne saurait trop y insister. Elles ne doivent pas contenir, en général, plus de vingt à trente lits; mais trop petites cependant, elles multiplient les angles rentrants, moins favorables aux malades que l'espace vide tout autour d'eux : c'est ainsi qu'une chambre de quatre lits, fût-elle grande, s'infecterait plus vite qu'une galerie ouverte où seraient couchées dix, vingt ou même trente personnes.

L'accès des salles doit être facilité par de vastes paliers à doubles portes, avec des escaliers doux à monter. On pourrait, selon le besoin et à volonté, agrandir, rétrécir ou diviser une salle par le moyen de cloisons mobiles. C'est ce que j'ai vu, par exemple, à l'hôpital militaire de Bayonne, que je considère comme un modèle à peu près complet des établissements hospitaliers. La construction en avait été confiée autrefois à un officier du génie qui s'était entouré, à cet effet, de toutes les lumières, de toutes les opinions utiles, et qui est devenu aujourd'hui le maréchal Niel.

Les salles de rechange, dont l'institution toute militaire remonte à une proposition du Conseil de santé des armées, vers la fin du dernier siècle, paraissent adoptées maintenant dans les hôpitaux civils, et doivent être soigneusement réservées pour l'Hôtel-Dieu.

J'exprimerais le vœu d'y joindre une salle de convalescence, comme je l'avais établie au Val-de-Grâce, lorsque j'en étais le médecin en chef, si cette proposition n'entraînait pour un hôpital civil l'inconvénient des abus et peut-être l'insuffisance de la discipline.

Les fenêtres à ouvertures élevées plutôt que basses, comme dans les hôpitaux anglais, dont a parlé M. Giraldès, offrent le double avantage d'assurer mieux l'aération de la salle, sans exposer les malades à l'action directe de l'air.

Le parquet, préférable au dallage, doit être frotté avec soin plutôt que lavé à grande eau, comme on le fait trop souvent encore, même dans les hôpitaux du Midi, où cette coutume paraît moins nuisible.

Sans m'arrêter aux détails de la literie, je dirai seulement qu'il faut se contenter, dans chaque salle, de deux rangées de lits, également espacés les uns des autres, selon un cubage d'air invariable, écartés des murs, composés d'un matelas et d'un sommier élastique, au lieu d'une paillasse, et proportionnellement disponibles pour assurer à quelques malades graves un lit de rechange, en même temps qu'une plus grande aération. Les lits de femmes conserveraient seuls des rideaux, mais habituellement ouverts jour et nuit.

Il suffirait d'affecter au nouvel Hôtel-Dieu 300 ou 400 lits, comme grand hôpital, sinon 100 ou 200 seulement comme petit hôpital, à condition de reporter 400 ou 500 lits sur un autre établissement à construire ailleurs. La solution de la difficulté me paraît satisfaisante, à cet égard, dans le remarquable écrit de M. Trélat.

Le point essentiel, après une juste fixation arrêtée, ce sera de ne dépasser jamais la contenance réglementaire des lits dans aucune salle, sous peine d'y provoquer les dangers de l'encombrement.

Il est inutile d'ajouter qu'à chaque salle seraient annexés deux cabinets à part, pour les maladies les plus graves, ou provisoires pour les affections contagieuses, ou bien encore pour les grandes opérations chirurgicales, mais à l'abri de l'air des salles.

Une propreté minutieuse et bien réglée, des soins de charité intelligente, comme ceux que miss Nightingale a si bien exposés, l'installation la plus favorable des latrines et l'application des water-closets de l'hôpital Saint-Louis ou de tout autre système reconnu le meilleur, compléteraient les conditions d'hygiène les plus désirables pour l'Hôtel-Dieu.

Nous n'avons pas, Messieurs, à examiner ici la question spéciale et cependant si essentielle du régime alimentaire, dont l'amélioration progressive occupe encore l'administration des hôpitaux civils comme celle des hôpitaux militaires.

Mais il faut espérer que la reconstruction de l'Hôtel-Dieu procurera aux malades, avec le bienfait d'une aération salutaire, le privilége dont manquent la plupart des hôpitaux de Londres, l'exercice au grand air, dans un promenoir qui deviendra le square de l'hôpital.

Attendons aussi de l'autorité municipale le soin d'assurer aux malades le repos et le bien-être si propices à leur guérison, en les préservant le plus possible de toute habitation contiguë, des bruits du voisinage et de la proximité des établissements insalubres.

Le choix, la répartition et l'évacuation bien entendus des malades sont en définitive d'une grande importance, pour maintenir dans les hôpitaux les conditions de salubrité nécessaire et pour prévenir le développement sur place des affections nosocomiales, soit sporadiques, soit épidémiques, à plus forte raison contagieuses, dont les conséquences deviennent si funestes aux opérations chirurgicales. Il suffit de nommer l'érysipèle, la phlébite, l'infection purulente, la pourriture d'hôpital et par-dessus tout le typhus, pour démontrer, une fois de plus, combien cette question seule est capitale pour l'Hôtel-Dieu. Elle a été soulevée avec beaucoup de raison par M. Verneuil, et elle mériterait d'être reprise complétement, au point de vue des appréciations les plus autorisées de la Société de chirurgie.

La mortalité dans les hôpitaux a été si souvent le sujet de recherches utiles, que je ne crois pas nécessaire d'y revenir en ce moment. Elle a été comparée dans les grands et dans les petits hôpitaux, dans les hôpitaux civils et dans les hôpitaux militaires où la mortalité diminue proportionnellement à l'application des règles de l'hygiène, comme M. Legouest l'a très-bien démontré pour les hôpitaux de la garnison de Paris et de Vincennes.

Permettez-moi seulement, Messieurs, de rappeler ici, ne fût-ce que comme digression, un argument considérable à l'appui de l'opinion que, pour ma part, j'avais longuement développée dans la discussion de l'Académie de médecine.

Les terribles effets de l'encombrement avaient entraîné des désastres, dans la campagne de Crimée; le choléra, la dyssenterie, le scorbut, la pourriture d'hôpital, et par-dessus tout le typhus, avaient décimé nos troupes. D'aussi grands malheurs pouvaient se reproduire dans une nouvelle guerre, il s'agissait de les prévenir, et ce fut vers ce but que tendirent tous mes efforts, lorsque j'eus l'honneur d'être nommé médecin en chef de l'armée d'Italie. Ma position, comme chirurgien de l'Empereur, me faisait doublement un devoir de solliciter auprès de Sa Majesté la latitude la plus étendue pour obtenir des autorités militaires et administratives la dissémination constante et l'évacuation régulière des blessés, en multipliant partout les secours hospitaliers. C'est ainsi qu'à part nos ambulances réglementaires et d'innombrables maisons de secours, nous avons transformé la plupart des établissements publics en hôpitaux, jusqu'à en compter 23 à Milan et 38 à Brescia. Mais aussi la conséquence finale de cette vaste diffusion a été de prévenir l'encombrement et de préserver l'armée de toute épidémie.

Et maintenant, Messieurs, si je cherchais à rétablir le lien de la discussion, interrompu peut-être par cette courte digression, je dirais que la population des hôpitaux de Paris forme aussi une armée entière dont il faut sauvegarder la conservation par la multiplicité des soins, par la dissémination des malades et par l'évacuation des convalescents. Ce que l'on fera pour tous les hôpitaux en général dans cette direction, deviendra un bienfait particulier pour l'Hôtel-Dieu.

L'institution des secours à domicile tend d'ailleurs de plus en plus à seconder efficacement l'Assistance publique, depuis que son ancien directeur, M. Davenne, en a dignement pris l'initiative à Paris. C'est donc une œuvre qui doit contribuer aussi à la salubrité des hôpitaux.

La reconstruction de l'Hôtel-Dieu intéresse enfin l'enseignement clinique dont la Société de chirurgie saura proclamer hautement l'importance. Les traditions de l'école de Desault et l'ancienne renommée de Dupuytren nous en font un devoir. Je crois cependant que le permis d'entrée pour les élèves devrait être exclusivement accordé aux ayants droit, afin de mieux assurer leur instruction pratique, afin d'éloigner de là tous les curieux que nous avons vus autrefois se presser en foule dans les salles et autour des lits, afin surtout de préserver les malades graves des inconvénients journaliers d'une trop grande affluence de monde au milieu d'eux.

On pourrait d'ailleurs étendre très-utilement les ressources de la clinique aux consultations du Bureau central, en consacrant par exemple deux heures par jour aux élèves, qui trouveraient là un complément d'instruction sans cesse varié, et qui sauraient s'inspirer doublement des devoirs de leur carrière, auprès des maîtres et auprès des malades.

Je termine ici, Messieurs, ce trop long discours, en vous remerciant de votre bienveillante attention, et en vous soumettant, sous toutes réserves, quelques propositions qui expriment de simples vœux de ma part. Puissent ces propositions, comme je l'espère, s'accorder avec les vôtres, et mériter l'approbation de l'autorité supérieure, au moment où elle semble suspendre ses dernières décisions sur l'entreprise de reconstruction de l'Hôtel-Dieu !

Voici ces propositions, les unes générales, les autres spéciales :

1° Propositions générales :

Reconstituer et agrandir la commission médicale des hospices, pour en former un conseil d'hygiène des hôpitaux civils.

Ce conseil serait composé du directeur de l'Assistance publique, président, de quatre médecins et de quatre chirurgiens honoraires des hôpitaux, dont deux appartiendraient à l'enseignement clinique, d'un pharmacien honoraire, membre de l'Académie, d'un ingénieur et d'un architecte de la ville. (Chaque hôpital aurait un conseil d'administration, et le directeur ne serait plus seul responsable.)

Une inspection médicale des hôpitaux serait confiée aux membres de ce conseil, mais dans les attributions propres et exclusives à chacun d'eux.

Une inspection complète de tous les hôpitaux actuels en apprécierait l'utilité, d'après l'emplacement, la construction, l'emploi et les transformations ou perfectionnements nécessaires, en examinant ensuite la question des hôpitaux futurs à créer, selon les besoins de la ville de Paris.

2° Propositions spéciales :

Reconstruire l'Hôtel-Dieu de 300 à 400 lits au plus, non dans la Cité, où sa place n'a plus de raison d'être et entraînerait, sans nécessité, des frais immenses, mais sur le terrain occupé par l'annexe, c'est-à-dire sur la rive gauche, avec toutes les conditions de l'hygiène hospitalière.

Ou bien, si l'emplacement de la Cité devient inévitable, par des considérations étrangères ou supérieures à notre appréciation, il conviendrait au moins d'y réserver le plus grand espace possible pour un petit hôpital de 100 à 200 lits seulement.

Ce petit hôpital serait exclusivement destiné à des malades graves, hors d'état d'être transportés ou secourus ailleurs. Il pourrait, en conservant la dénomination d'Hôtel-Dieu, servir de type ou de modèle aux *maisons de secours*, dont l'installation sera plus tard sans doute reconnue nécessaire au centre de chaque arrondissement.

Il sera indispensable, en même temps, de construire un nouvel hôpital de 400 à 500 lits, vers le nord-est de Paris, dans le quartier Popincourt, où prédomine aujourd'hui la classe ouvrière, en ménageant d'avance à cet établissement hospitalier un vaste terrain d'acquisition, mais en différant jusque-là de démolir l'ancien Hôtel-Dieu.

Dr Parkes
with the author's best compliments

CAN INDIA BE COLONIZED BY EUROPEANS?

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4. *On Ethno-Climatology; or the Acclimatization of Man.* By James Hunt, PH. D., *in the Report of the Thirty-First Meeting of the British Association for the Advancement of Science, held at Manchester in September* 1861.
5. *Introduction to Anthropology.* By Dr. Theodore Waitz. Edited by J. Frederick Collingwood, 1863.

THE question—*Is it physically possible to colonize India by Europeans?* comes home, in some way or other, to the feelings or the interests of every man dwelling between Cape Comorin and Peshawur. The enterprising speculator, the world's pioneer, seeks in Assam and Cachar, in the Dhera of the Dhoon, upon the slopes of the Himalayas, of the Neilgherries and the Shevaroy Hills, for lands, which, although now waste and of low value, promise, hereafter, under the skilled labour of the British agriculturist, to become the sites of such tea plantations as China never saw, and of cinchona forests, in comparison with which the ill-regulated and failing bark-supplies of the Peruvian Andes will be but as withered leaves and rotten wood. The English mother, as she gazes—how possibly for the last time in this life—on the sweet little white face and tearful eyes of him who, yesterday, was the tyrant and the darling of a Mofussil bungalow or a Calcutta mansion, now ranged with some fifty other troubled little white faces down at the Outer Floating Light, around the tables of our Toynbees and our Daniells, turns away from the fatherly assurance of the kind seaman's voice, and sobs, 'Has God set apart no place in India, where my child might 'live?' Our Government—deeply conscious of the terrible fact that, in their European Army stationed here, every regiment has lost, by death, on an average, a company,—one bayonet in every ten,—every twenty months during the last hundred years,—is earnest in seeking out cool and elevated spots, where their troops may be advantageously posted out of the fierce rays of the sun and above the range of the deadly fever-steam.

It is known to this benevolent Government that, in the barracks of the Plains, the mortality among their soldiers' children, of pure European race, more than trebles that frightful death-rate which prevails among the infants of the poor at home. They, therefore, at the instigation of Henry Lawrence, maintain schools for soldiers' children at Sanawur, Murree, Mount Aboo, and Ootacamund, and are, we believe, deeply solicitous to save many more of these little brands from the burning, and to rear them in the Hills to become, hereafter, wielders of their fathers' arms.

The same Government, perceiving how greatly the extensive introduction and wide diffusion of an European industrial element in India would tend to develop the vast and still almost uncomputed resources of this country, equally to the benefit of the natives and of ourselves, seek anxiously to ascertain whether there are not extensive tracts of country in the three Presidencies, where the stout agriculturists of Britain may form colonies, and fields, and homes, and rear around them a race at least equal to themselves in vigour and intelligence.

Thus it will, we think, be perceived, even from these few and very scanty illustrations, that there are not many amongst us whom this question, as to the practicability of colonizing India by Europeans, does not practically concern.

Wherever a nation has assumed a forward place among the dominators of the world, it has become a centre of immigration. It has sent forth its armies to conquer new lands; and, in those subjugated territories, it has established, on a more or less extended scale, commerce, its own standard of civilization, its language, its arts, and often its religion.

In eliminating these first elements of colonization, we begin to perceive the wisdom and goodness of the Almighty in placing swords in men's hands. Here the natural development of God's ordinance provides that, at no distant period, the falchion of the invader becomes changed into the reaping-hook of the colonist.

All the nations with whose histories we are fully acquainted have been peopled by a succession of what may be termed immigrant waves. Everywhere, whether by warlike invasion or peaceful immigration, race has followed and supplanted race.

Into Britain flowed successively, during a course of centuries, the armies and the colonists of the Roman, the Dane, the Saxon, and the Norman, dispossessing and supplanting the Celt, (who clearly owed his origin to some race of Aryan strangers from the East,) and driving him into the remote mountainous fastnesses of the land.

In India, the Turanian (doubtless, himself, an interloper from the North and East,) has been, in like manner, displaced by the early Aryan, the Hindu, and the worshipper of Mahomed, among whose descendants the power of England has, for the last century, been paramount.

The text-word of the world's history is **Progress.** Throughout all time we perceive mankind ever pressed forward by a Divine impetus towards a standard of perfectibility fixed by the All-Wise.

Our Faith and our Science combine to teach us that the life of the world is, like our own lives,—finite.

As it has been ruled that intellectual man shall, in passing from his cradle to his grave, accumulate knowledge, experience, skill, the power of fitting his mind for that immortality which is its sure inheritance, so the spirit of the world, emerging from infant barbarism, steadily advances, by arms, by arts, by civilization, and by the spreading of the True Faith, towards that happy millennium which has been promised as the crown of its green old age.

Like the life of the world, and the life of every man and animal inhabiting it, the life of every nation (with perhaps one exception) is but a finite thing. Excluding the instance of that peculiar people, the Jews, we find all historical experience demonstrating the fact that every nation, be it strong or weak, has its period of infancy and also its term of senility—upon which, sooner or later, its political death ensues.

Carrying on the analogy, without at all overstraining it, we may say that Colonization and Settlement are to the nation what birth, marriage, and death are to the individual. The first shout of the immigrants, when they see stretched before them the plains of that promised land towards which they have travelled from afar, is the same as the first cry of the infant at its birth, the first self-gratulatory murmur of the heir when he enters upon his inheritance. The extensive settlement of foreigners in a nation is that nation's marriage, whereby it extends its alliances, whether for good or evil, and, by an intermingling of races, either improves or deteriorates its population. Again, if any law in the history of mankind can be looked upon as fixed and certain it is this:—Whenever a country becomes the seat of extensive and successful colonization, its former occupants, with the exception of a scattered remnant, speedily die out. The old man passes away, and the heir reigns in his stead.

Whether this last result be the development of an immutable natural law, or the avoidable issue of certain errors on the part of the conquerors and the conquered is, however, a questionable point, which we are not called upon to discuss here.

What may be termed the instinct of colonization,—that impulse to go forth, discover, and conquer, and then to multiply in and replenish new territory,—has been implanted by the Creator in all animated beings.

As surely as the fledgeling, conscious of possessing the gift of flight, casts himself from the nest and spreads his pinion to the breeze, as certainly do many of the tall sons go forth from the castle and the homestead, never to meet sire and mother again, until fame and fortune have been won, or until, at the sounding of the last trump, the sea shall give up its dead, and the voice of an archangel shall call over the muster-roll of those who have died in battle for their countries' cause. That same power, which sends the dragon-fly from the alders to hover above the mill-stream, and to spend the few bright hours of its existence among the wild flowers on the other bank, mans our navy and recruits our army. The same God-implanted instinct which, yearly, leads hundreds of delicately nurtured children to tear themselves from their mothers' arms and to dare the sufferings and the perils of a seaman's life, urged Humphrey Gilbert—ever intent upon the discovery of a North-West passage to India—forth upon his last voyage, and prompted his dying cry in that dreadful tempest which swallowed up his ship—'Courage, my lads, we are as near heaven at sea as on the land.' This noble instinct, we may be assured, sustained Franklin and the learned, brave and devoted men who accompanied him upon his quest straight into the unknown region of eternal snow, right onward even unto death.

A practical-minded modern writer states the case very much as it stands, being content with the fact without troubling himself about the reasons, when he tells us that 'It is the genius of 'our restless, discontented English nation to go blundering about 'the world like buffaloes in search of fresh pasture.'

This migratory spirit has ever been most actively aggressive among the young, the strong, and the ardent of the dominant races. It assumes every form, from the noblest to the basest,—patriotism, ardour for conquest or for the propagation of

religion, scientific zeal, independence, curiosity, daring, love of travel and adventure, ambition, cupidity, the greed of gain. Divested of this instinctive migratory spirit, this stirring of the Viking blood, no country could ever assume the position of a military, naval, or mercantile power.

We need not occupy much time in explaining the broad, practical difference which exists between *Settlement* and *Colonization*. The settler enters a foreign country as a guest, sometimes as an intruder, or, at least, distinctively as an alien. The colonist goes in and occupies as an invader or an heir.

Settlement is, of course, colonization on a small scale, and the less frequently runs into the greater.

In these remarks, we shall understand that the *Colonist* is one who, adopting a new home in a foreign country, determines that he and his children's children shall continue to inhabit that land as their own proper and permanent abiding-place. We shall consider that the *Settler* is one who merely holds himself to be a bird of passage, a foreigner, and temporary sojourner, still belonging to his native country. The Pilgrim Fathers, who, in 1619, landed from the Ship *Mayflower* on Plymouth Rock, in Massachusetts Bay, were colonists. We Britons, who pass a certain number of our years in India with an energy proportioned to our expectation of being allowed to die at Home, are settlers.

No race can be regarded as colonists in a land, the climate of which is such as to preclude them from fully engaging in field labour.

It is a very remarkable and certain fact that the Creator has laid down a system of purely physiological laws, (into which we, as ethnologists, are only now beginning to obtain an insight); which laws most potentially limit and control man's power of settling in and colonizing foreign lands.

For the sake of practical illustration, these laws, or rather their manifestations, may be divided into three leading classes.

1. Those which freely permit and encourage Settlement and Colonization.

2. Those which utterly prohibit either Settlement or Colonization.

3. Those which, permitting Settlement, absolutely forbid Colonization.

Let us briefly consider these laws in detail. *First*, those which freely permit and encourage Settlement and Colonization. The strongest type of these laws may be found in those passages of Scripture which lay down the conditions under which the people of Israel, emigrating from Egypt, colonized the Holy Land.

Behold I have set the land before you, go in and possess the land.—*Deut.* i. 8.

The Lord thy God bringeth thee into a good land.—*Deut.* viii. 7.

I will give you the rain of your land in due season, the first rain and the latter rain, that thou mayest gather in thy corn and thy wine and thy oil.—*Deut.* xi. 14.

Then will the Lord drive out all those nations from before you and ye shall possess greater nations and mightier than yourselves.—*Deut.* xi. 23.

Every place whereon the soles of your feet shall tread shall be yours.—*Deut.* xi. 24.

There shall no man be able to stand before you, for the Lord your God shall lay the fear of you and the dread of you upon all the land that ye shall tread upon.—*Deut.* xi. 25.

By little and little I will drive them out before thee, until thou be increased and inherit the land.—*Exod.* xxiii. 30.

The Lord God of your Fathers make you a thousand times as many more as ye are, and bless you, as he hath promised you!—*Deut.* i. 11.

There shall not be a male or female barren among you, or among your cattle.—*Deut.* vii. 14.

Blessed shalt thou be in the city, and blessed shalt thou be in the field.—*Deut.* xxviii. 3.

Blessed shall be the fruit of thy body, and the fruit of thy ground, and the fruit of thy cattle, the increase of thy kine and the flocks of thy sheep.—*Deut.* xxviii. 4.

In blessing I will bless thee, and in multiplying I will multiply thy seed as the stars of the heaven and as the sand which is upon the sea-shore.—*Gen.* xxii. 17.

And the Lord will take away from thee all sickness.—*Deut.* vii. 15.

Your threshing shall reach unto the vintage, and the vintage shall reach until the sowing time, and ye shall eat your bread in the full, and dwell in your land safely.—*Levit.* xxvi. 5.

I will rid evil beasts out of the land, neither shall the sword go through your land.—*Levit.* xxvi. 6.

It will here be seen that the Creator, from whose liberal hand flow all the blessings of life, strength, health, and wealth which we enjoy, favoured the physical circumstances of his chosen people, the Jews, in a preternatural manner upon their entrance into the Land of Promise. The extremely rapid increase of the immigrant race is, however, even in the present day, the leading test of success in colonization. Thus we are told that England doubles the number of her people in about one hundred years, Scotland in about one hundred and fifty; in America, not many years ago, they were being doubled in about twenty-five years; and it is reckoned that, in less than ninety years, if the rate of increase which prevailed before the present lamentable war continues, the American population will be more than two hundred millions. We, however, know that, whenever a country becomes adequately peopled, the rate of increase in its population abates. In 1790 the United States contained less than four millions white inhabitants. In 1840 this population had risen to upwards of seventeen millions. The rate of immigration into the United States from Europe was quite inadequate to account for this great and rapid increase.

Some idea of the manner in which the population increases in healthy and prosperous colonies may be obtained from the following obituary notices which appeared in one page of the *Gentleman's Magazine* for March 1791:—'1789, at Northampton, 'in Massachusetts, in North America, aged ninety-two, Mr. Josiah 'Clark. He was the youngest of eleven children (six sons and five 'daughters), three of whom lived to be above ninety, four above 'eighty, and three above seventy years of age. From the six 'sons only have descended 1,158 children, grand-children, and 'great grand-children, of whom 925 are now living.

'*December.*—At Dedham, in Massachusetts, aged ninety-two, 'Captain Ezra Morse. He had 262 descendants, of whom 216 'survived him, and of these, thirty-five were of the fifth genera-'tion, several of whom have reached their fifteenth and sixteenth 'years.'

At present this remarkable law of prosperous increase is said to be most remarkably prevalent in California.

We cannot but think that a study of the laws of population in thriving colonies, to which we have now so slightly alluded, would lead Bishop Colenso to qualify much that he has so confidently stated, especially in his 17th Chapter, on 'The number of the 'Israelites at the time of the Exodus.'

In alluding to the fact that, under their admirable system of discipline, the Roman soldiers maintained health and vigour in all climates, including parts of Asia and Africa, Gibbon remarked that 'man is the only animal which can live and multiply in 'every country, from the Equator to the Poles;' this truth has to be received with many and considerable qualifications.

It is unquestionable that, even under the most successful circumstances of colonization, as for example in the great European colonies of North America, Australia, and the Cape of Good Hope, the later colonial offspring display a very general and manifest tendency to degenerate physically from the robust and vigourous type of the original parent stock. This falling off is principally displayed in deficiency of muscle and remarkable slenderness of figure, and in that tendency to the early decay of the teeth, which renders the profession of dentistry so flourishing an undertaking in most of the Colonies.

It is, indeed, held by some very high authorities that the races of men can thrive and permanently maintain themselves only in those localities to which they appear originally to belong. There is a foundation of truth in this idea, but we think that the rule can only be rigidly applied to those who colonize regions, the climate of which is very different from that of their native land. A very able writer thus states the extreme view—'Is the Spaniard 'thriving in South America, the Celt or the Saxon in the Northern 'half? Is there true Colonization in India? Does the English-'man flourish in the islands of the Gulf of Mexico? Could the 'Negro inhabit Lapland, or could the Northman long flourish on the Senegal or Gambia? Is the Red Man fitted for a large 'portion of the Western Hemisphere, and does the White Man wax 'strong amidst the forests of the Far West? Is the standard of 'health as high among the inhabitants of the Union as it is among 'their progenitors' [brethren ?] 'in the British Isles? To point 'to quarters of the globe at present peopled by races foreign to 'the land, and apparently flourishing commercially, as facts 'opposed to such doctrine, is to be open to the reply that annually 'into these countries have been and still are imported thousands 'upon thousands of immigrants representing some of the best blood 'of the colonizing stock. To be able to form a satisfactory conclu-'sion, this constant replenishment must be arrested, and a 'sufficient length of time allowed to elapse to enable us to see how 'the foreign race could then propagate and maintain itself in its 'adopted clime. We believe it would fail and generally die out, 'and that the period would come, however distant, when the 'Saxon would no longer be found in Australia, in Kentucky, in 'Tennessee. Again, we all know that, in the usual places of 'resort of Europeans within the tropics, the aliens can continue 'to reside with comparative impunity if moderate caution be 'adopted. But this is all, whether it be the Rio Formosa 'or the Rio Colorado, Ashantee, or Madras, whether it be Bengal 'or Jamaica, Cape Town or Canada, Hispaniola, Chili, Cuba, 'or Peru, no true European stock can *permanently* colonize the 'place. We have held India for more than two hundred years, 'yet we cannot colonize an inch of it. We have planted the 'white man in America, and there he degenerates!'

It is strikingly remarkable to how very short a distance, whether north or south of his own proper habitat or ethnic circle, man can remove without sustaining considerable detriment. In the paper on Ethno-Climatology, the title of which stands at the head of this article, Dr. James Hunt shewed that the English, when sent to any part of the Mediterranean, suffer far more than in England. It has been proposed to locate British troops at the Mediterranean stations for a time before they proceed to India. This authority suggests that, under such an arrangement, the soldier might gain some advantage in acquiring those habits of caution which a hot climate demands, but he, with great show of justice, apprehends that, if the troops were located in the Mediterranean for a few years before coming to India, the mortality would be far higher when they arrived here, as a large proportion of the men would land with deteriorated constitutions.

Having thus given a mere glimpse of the laws which govern Colonization and Settlement in their more successful aspects, we shall now allude to those which utterly prohibit either Settlement or Colonization.

All countries in which there is much of that deadly poison or miasm, generated in marshes, which gives rise, in its mildest and simplest form, to ague, and in its more concentrated and pernicious developments to dysentery, remittent fever, and cholera, are peculiarly unfavourable to strangers. Thus it very rarely indeed happens that any stranger, whether Native or European, fails to suffer, more or less, from illness during the first month of his sojourn in Calcutta. There are tracts in the Himalayan Terai country where, although the aboriginal inhabitants contrive to exist, all settlers from outside either die or are driven out by disease. Other parts of the Terai are absolutely uninhabitable, and can only be entered at certain seasons. Most of our readers must retain stamped upon their memories Lord Macaulay's last great word-picture,—his narrative of the Darien calamity in 1699. Lured on by the brilliant speculations of an honest but over-ardent financier, and by very narrow historical research chiefly into the accounts of missionaries and pirates, who appear to have visited Darien only during the healthy season, and to have described it as a paradise, unaware or regardless of the warnings contained in the works of Hakluyt and Purchas, which shewed that Darien was noted, even among tropical climates, for its insalubrity,—twelve hundred seamen and colonists embarked from Leith in the summer of 1698, determined to form a settlement upon that narrow isthmus which unites the North and

South American continents, their design being to construct roads along which a string of mules or a wheeled carriage might, in the course of a single day, pass from the Atlantic to the Pacific Ocean, concentrating in that point the whole traffic between India and Europe, thus securing what Sir John Dalrymple called 'the Gate of the Oceans,' and wholly obviating the necessity for the tedious and dangerous voyage to India and China round the Cape of Good Hope. They reached their destination in November, and established their settlement of New Edinburgh on a small peninsula. The accounts of the first settlers were so encouraging that, in the following August, thirteen hundred more adventurers embarked to join them. Two months later, it was known in London that the Colony of New Caledonia was no more, and that only a few men, broken alike in spirit, fortune, and constitution, had found their way to New York, muttering the tale of a destruction only surpassed by that which the waters of the Red Sea concealed from light. During the cool months which immediately followed their landing, but few deaths occurred; but, before the equinox, pestilential marsh fevers became prevalent, and the deaths gradually increased to ten or twelve a day. Those who were not laid on their beds were so broken by disease as scarcely to be able to move the sick and bury the dead. The shattered remnant embarked on three ships. Upwards of three hundred and ninety persons died on the voyage to New York. Meanwhile, the second expedition reached Darien about four months after the first settlers had fled. 'They had,' in the words of the great historian, 'expected to find a flourishing young town, secure 'fortifications, cultivated fields, and a cordial welcome. They 'found a wilderness. The castle of New Edinburgh was in 'ruins. The huts had been burned. The site marked out for 'the great capital, which was to have been the Tyre, the Venice, 'the Amsterdam of the eighteenth century, was overgrown 'with jungle and inhabited only by the sloth and the baboon.' They, however, re-occupied the ruins and commenced repairs. 'The months which immediately followed their arrival were,' we are told, 'the coolest and most salubrious of the year.' But, even in those months, the pestilential influence of a tropical sun shining on swamps rank with impenetrable thickets of black mangroves, began to be felt, and the mortality was great. Before the end of March they were compelled by the Spaniards to evacuate their settlement. They departed early in April, having lost by disease, in the four healthiest months of the year, three hundred men out of thirteen hundred.

We have evidences of the fact that, where a sufficient number of human lives have been expended in the destructive labour of improvement, spots quite as pestilential as New Caledonia have been made inhabitable; but this has no special bearing upon the point in question, as, practically, it is impossible to form settlements, much less colonies, in such localities.

We shall now, in considering the developments of those laws, which, permitting settlement, absolutely forbid colonization, begin to deal with the question immediately before us;—the Settlement and Colonization of India by Europeans.

It has been truly remarked by Dr. William Aitkin, that the white races reach their highest physical and intellectual development, as well as most perfect health and greatest average duration of life above 40° in the Western and 45° in the Eastern Hemispheres; and that, whenever they emigrate many degrees below these lines, they begin to deteriorate from increased temperature, either alone or combined with other morbific influences incident not less to change of climate than to habits of life. In a tropical climate, like that of India, the European is literally, ethnologically, and physically, an 'Outsider' and 'Interloper.' He is, in no sense of the term, a colonist. He is scarcely even a settler; because he can never permanently settle down in a climate, the nature of which is so absolutely inimical to himself and his progeny. He must ever be an 'adventurer' in the land, adventuring his life with the absolute certainty of having a greater or less portion of it curtailed by the slow or rapid destructive influence of a climate to which his constitution can never thoroughly adapt itself. It was long believed that this adaptation of the constitution to climate, or acclimatisation, was a law of nature constantly operative among settlers in tropical climates. But no European ever becomes truly acclimatised in India; the shock of the first change from a cool to a hot climate has to be got over, and many, by learning the proper mode of living in the country, enjoy better health after a few years' residence than they did on first landing; but, as a general rule, the rate of mortality increases in proportion to the length of residence in India.

In like manner, Dr. Armstrong and others (as cited by Mr. James Hunt) have observed that Europeans resist the cold of the polar regions better the first year than they do the second, and that every subsequent year they feel the effects of the climate more. Further, Dr. James Hunt has amply proved, by statistical evidence, that, as age increases, so does the mortality in any place out of the native land of a people.

The injurious influence of tropical climates is not at all confined to the human race; the lower animals share it equally. English dogs, horses, and kine are generally unhealthy and short-lived in the East and West Indies, and their breeds cannot be maintained.

We shall consider as proved and granted the facts that the mortality among Europeans in India largely exceeds the Home rate, and that the annual death-rates from the most prevalent diseases, such as dysentery, inflammation of the liver, cholera, and pulmonary consumption, are, by a very large amount, higher among our European troops in this country than they are among the Sepoys.

We have already hinted that no body of men deserve to be regarded as colonists in a country where, feeling themselves incapable of enduring the necessary toil and exposure, they are compelled to engage the services of the natives of the soil in that field labour, without which the existence of a community can nowhere be maintained.

Few men can regard themselves as absolutely independent of the assistance of their fellow-men, but if there is any human being in the world who ought to feel that, to live, he must, under Providence, be absolutely self-reliant, it is the colonist—the opener out of new lands. Recently a local journal, in commenting upon some judicious but by no means novel views lately propounded by Dr. Lewis upon the restorative influence of the sun's rays in certain diseases, remarks :—'We have always thought that 'soldiers in India, and indeed Europeans in general, are too much 'afraid of the sun, and would be far more robust if they exposed 'themselves to its rays more than they do. It is not the sun 'that kills our men in India, but the seclusion to which they 'are restricted to avoid its effects, and the course of diet they 'pursue.' Here the remark on diet is not without justice, but the writer falls into the great mistake of confounding the sun's light with the sun's heat. The unwise experiments here recommended have been tried in India only too frequently. In their results they have resembled those of the man who attempted to keep his horse without food, and of the Czar Peter, who imagined that children could be inured to drinking sea-water. Just as the experimenters began to grow most sanguine, those experimented upon died. Hear what Dr. James Hunt has lately said on this point :—'Many writers have observed that, with the natives, 'those most free from disease are those who toil all day in the 'burning sun with no covering at all to the head. Ignorance as 'to the difference of race has induced some commanders to attempt

'thus to *harden* the Europeans, with results something frightful 'to contemplate. One of the regiments that had been longest 'in India, the Madras Fusiliers, is stated to have been reduced 'from eight hundred and fifty to one hundred and twenty fit for 'duty.' Many similar cases have been produced by needless exposure. Mr. Jeffreys says that 'Her Majesty's 44th Regiment, 'in 1823, were 900 strong, and a very fine body of men. The 'Commanding Officer insisted that confinement of the men during 'the day was effeminate, and continued drilling them after the hot 'season had begun. But the men suffered the penalty of the 'officer's ignorance.' 'For some months,' says Mr. Jeffreys, 'not 'less than one-third, and for some weeks, one-half of the men 'were in hospital at once, chiefly with fever, dysentery, and cholera. 'I remember to have seen, for some time, from four to ten bodies 'in the dead-room of a morning, many of them specimens of 'athletes.'

Every medical man who has seen much practice in India knows that natives are frequently killed by sun-stroke, and we may take it for granted, that nowhere in India, whether in the Shevaroy Hills, at Ootacamund, or in the Dhera of the Dhoon, will any circumstances of season, temperature or altitude justify us in employing Europeans continuously in field labour.

One of the chief impediments to the colonization of India by Europeans is the almost absolute impossibility of raising healthy children in the plains. Nearly every one understands this, practically and painfully, and the following illustrations of the fact are, doubtless, familiar to many of our readers.

According to Major-General Bagnold, the oldest English Regiment, the Bombay 'Toughs,' notwithstanding that marriages with British females are encouraged, have never been able, from the time of Charles II. to this time, to raise boys enough to supply the drummers and fifers.

In giving evidence before the Select Committee of the House of Commons on the affairs of the East India Company in 1832, Colonel Charles Hopkinson remarked that, when he was a subaltern in his Corps, it was his custom and duty to go round the places where the Europeans lived, to see that they were comfortable, and had got their houses and streets clean. In going there so frequently, he had an opportunity of seeing children in great numbers of pure European blood, yet, as long as he had been in the service, *he could not recollect above one instance where one of those children attained maturity.* The circumstance made a deep impression on him, and, for many years, he made enquiries on this subject, but he never could ascertain that, in any Corps, the children ever lived; if they did, many would then have borne arms or been serving in the public offices. This struck him the more forcibly from the circumstance of many young men who have come out as recruits in the artillery, wanting to get their discharge, to obtain which it was necessary a substitute should be provided. Now, if any, even a very small, proportion of those children born had lived to attain the age of maturity, there would have been no difficulty whatever in getting substitutes; but he never knew or even heard of one single instance, in the Madras establishment, where one was so procured, or where a man born in India, of pure European blood, ever attained an age sufficiently mature to be taken as a substitute.

So long ago as the year 1835, Dr. Twining, of Calcutta, published the question, 'Does the third generation of the European race exist in India, all the individuals being of pure European descent, and having been born and reared in this country?' This plain question has been known, probably, to every medical man throughout India for nine and twenty years. Many medical officers long engaged with European troops and attached to invalid depôts, have, to our knowledge, been greatly interested in its investigation, but, in no single instance has it ever been answered in the affirmative.

Of late years, much has been done to improve the condition of the European barrack children in the Military Stations of the plains of India, and the facts above stated and many others of equal significance led to the institution of those noble charities, the Lawrence Hill Asylums. We have, however, already shewn that, in the plains, the mortality rate among the barrack children is enormously high. (Here we must bear in mind Mr. Simon's remark,* that 'it cannot be too distinctly recognized that a high local mortality of children must always necessarily denote a high local prevalence of those causes which determine a degeneration of race'), and it is much to be doubted whether, in its politico-economic point of view, the experiment of bringing up soldiers' children in very remote hill stations, at a cost for which gentlemen's children could be boarded and educated for professions in Europe, can fairly be regarded as any part of a working system of true colonization.

Many of the details contained in the periodical reports of the Lawrence Asylum are very interesting and encouraging. Thus,

* Preface to Greenhow's Papers on the 'Sanitary Condition of England,' cited by Dr. Moore, of Bombay.

in that of the Mount Aboo School, for the year before last, it is mentioned that only three children have died there in nearly eight years, during which the strength of pupils ranged from twenty in 1855, to from fifty to sixty in 1860-61. The general appearance and development of the little ones are said to display the beneficial results of their sojourn in so favourable a climate. During the year under report two of the eldest boys, aged fifteen and a half and sixteen years, were provided for, and two girls were married at the respective ages of sixteen and seventeen years.

On the other hand, the cost of this experiment must again be adverted to. It cannot be anticipated that the average of European colonists in India could afford to pay, say £20 to 25 annually, for the maintenance of each of their children in the Hills. Those who could do so would much prefer to send their children home. Two years ago, Mr. Walker, of Bombay,* shewed that the revenue of the Byculla, Poonah, and other Bombay Schools would afford £22 11*s.* 7*d.* per head annually, and argued that, with such a revenue as this, the soldiers' children could be well fed, clothed, and educated in a fine healthy part of Yorkshire, where food, fuel, and clothing are cheaper than in any other part of the world. The experiment of the Lawrence Schools is so new that we are still not in a position to judge how far the children brought up in these isolated spots, within or not many degrees above the tropic line, will equal their English cousins in mental and bodily vigour. In writing on the climate of the Neilgherry Hills, Dr. Mackay remarks—'Children brought up here, apparently strong and healthy in their youth, in after years shew constitutional weaknesses, and this I have observed to be the case particularly with females.'

Further, it is greatly to be feared that the best of our Hill Sanitaria will, the longer they are occupied, and the more the various insanitary influences almost inseparable from residence within very limited spaces accumulate about them, lose much of that reputation for great salubrity, which, in every one of them, with the exception of Darjeeling, Nynee Tal, and Murree, is already on the wane. The extra-tropical hill Sanitaria of the Bengal and Bombay Presidencies generally afford but little dwelling space for large bodies of men, and we have strong medical grounds for believing that, should these localities ever become overcrowded, maladies partaking of the most malignant characters of the diseases of both cold and tropical climates will attack the settlers.

* The *Times of India* for November 25th, 1861, as cited by Dr. W. G. Moore, of Bombay.

In the mountain Sanitaria of Madras, the pernicious influence of a fierce tropical sun, which no elevation or atmospheric rarefaction can wholly counteract, will always prove an insuperable obstacle to Europeans seeking to maintain themselves by labour in the open air.

It is by no means certain that the climate of these great altitudes would, in the long run, prove favourable to any race, whether European or Native, immigrant from plain countries. It is known that, although the native Peruvian thrives and remains free from pulmonary complaints at an altitude from 7,000 to 15,000 feet above the level of the sea, such altitudes, as in Quito, are frequently destructive to the white.* D'Orbigny goes so far as to assert that in Peru, at the altitude above mentioned, the form of the trunk is changed by the influence of respiration, the body is short but compact, whilst the inhabitants of the damp lowlands are more slender in form. Recognising the fact that the anatomical construction and physical constitution of every animal is distinctly adapted to that habitat in which Providence has located it, we have the strongest doubts whether any people, coming from the plains of Europe, could successfully colonize the mountains of India.

The world has never yet seen a truly successful attempt to colonize, in anything like an adequate sense of the term, a tropical district by Europeans, and here it must be borne in mind that all the extra-tropical country of our three Presidencies is visited by an almost more than tropical heat and by the worst tropical diseases. The only instance of the apparent success of such an undertaking is that of the Spaniards, who have been, for many generations, settled in tropical America. The evidences of this success, however, are neither strong nor encouraging. Upon this question Dr. Hunt has the following very striking remarks:—"Some authors think that the question of the European
" propagating himself in the tropics has been settled by the fact
" that, for three centuries, the Spanish race has lived and thrived
" in tropical America." Mr. Crawfurd says:—" 'The question,
" ' whether the European race is capable of living and multiplying
" ' in a tropical or other hot region, seems to have been settled in
" ' the affirmative on a large scale in America. Of the pure Spanish
" ' race there are, at present, probably not fewer than six millions
" ' mostly within the tropics. But it is a wholly gratuitous
" ' assumption, unsupported by facts, to suppose that anything
" ' like this number of the Spanish race exist in America. If

* Waitz.

" ' we were to read for Mr. Crawfurd's 'millions' the word
" " thousands,' we should, perhaps, be nearer the truth. In
" ' Mexico, it is estimated that there are not more than ten
" ' thousand of the pure race, reckoning both Creoles and immi-
" ' grants.* What a small proportion is this to those who left
" ' their native land and have never returned again! For three
" ' hundred years Spain has poured out her richest blood on her
" ' American Colonies, almost at the price of her own extinction,
" ' without the slightest prospect of being able to establish a
" ' Spanish race in Central America. Never was there a greater
" ' failure than the attempt of the Spaniards to colonize tropical
" ' America. Those who have watched the gradual change of
" ' the Spanish Colonies must be convinced of the fallacy of
" ' quoting this as a case of successful colonization of tropical
" ' countries by Europeans. When the continual influx of new
" ' blood from Spain was taking place, the change was not so much
" ' observed; but now immigration has ceased, the pure Spanish
" ' race is diminishing rapidly. All recent observations shew
" ' that the Indian blood is again shewing out in a most remark-
" ' able manner. Instead of the Spaniards flourishing, there
" ' seems every prospect of their entire extinction, unless fresh
" ' blood is sent from Europe. The extinction of the Spanish race
" ' in America was likewise predicted, more than twenty years ago,
" ' by Dr. Knox. There is no doubt that this result has been
" ' greatly owing to the mixture of Spanish and Indian blood.' "

The evidences of the fact that the European race degenerates miserably in South America are overwhelmingly strong.

Many years ago, M. Pauw stated that the Creoles, descending from Europeans and born in America, though educated in the Universities of Mexico and Lima, and of College de Santa Fé, have never produced a single book. The Creoles, both of North and South America, he adds, come to a maturity of intellect, such as theirs is, more early than the children in Europe; but this anticipation of ripeness is short-lived in proportion to the unseasonableness of its appearance; for the Creole falls off as he approaches to puberty; his vivacity deserts him, his powers grow dull, he ceases to think at the very time that he might think to some purpose; hence it is commonly said of them that they are already blind at the time that other men begin to see.

* It has since been asserted, in the Cortes, by Don Pachero, that the pure Spanish race in Mexico does not amount to more than eight thousand. In 1793, Humboldt estimated the pure Spanish race, in New Spain, to consist of 1,200,000.

Dr. Waitz has accumulated a vast mass of proofs to the same effect. We shall quote some of his facts, omitting the references for the sake of brevity :—

'In the plains of Cordova and San Luis (Argentine Republic) the pure Spanish race predominates ; the young females are frequently of a white rose colour and delicate structure. Yet living in a state of isolation, the Spaniards have not exhibited greater activity and a stronger tendency to civilisation than the Aborigines of that country. The German and Scottish Colonies south of Buenos Ayres, with their flourishing and neat villages, form a decided contrast to the former. The white settlers south of Buenos Ayres are scarcely less rude and barbarous than the Indians. Criminals and the scum of all nations who take refuge among them instruct them in all that is wicked. Many cruelties and devastations are committed by these lawless men, over whom the Indian Chiefs have no authority. The Creoles of the La Plata States are almost as godless and dirty as the Indians. To construct windmills is beyond their mechanical talent, and, notwithstanding the great fertility of the soil, there is no garden to be seen on the high road from Buenos Ayres to Barranquitos. Except in the villages there is no cultivation of the soil. To catch lice is the chief amusement of the women, who offer them to strangers as dainties. They are dirty beyond measure ; they are even deficient in curiosity. A similar description is given of the inhabitants of Tucuman. The Indians of Rioja are simple-minded, sober men, whose disputes never lead to bloodshed ; they are more industrious and persevering than the Spanish Creoles, and their festivals never exhibit the same coarseness which distinguishes those of the Creoles. Many of the common utensils and tools of the Chilians, carts, looms, ploughs, are extremely clumsy, scarcely better than those of the Indians ; the axe is chiefly used, the saw but little. They are outdone by the superior agriculture of the Araucarians—they are very cleanly in their persons, they bathe several times daily, and by their cleanliness in the villages the Indians of the Tropics in America contrast with the immigrant South Europeans. In the vicinity of Talcahuano (Chili) D'Urville found such miserable dirty huts, that they could scarcely stand comparison with the habitations of the Polynesians. Helus, after describing the indolent habits of the Creoles of South America, adds, 'The Indians are the only industrious class in the country.' The colonists in the Llanos of Curracas are too lazy to dig a well, though they know that they could find the finest springs at the depth of

ten feet. Even at this day there may be found in New Spain flourishing Indian villages and a well cultivated soil, near miserable villages of white Creoles. Ploughs are there in use made of wood without any iron, and are always drawn by oxen, never by horses ; and the Spanish Californians, whom Simpson has described as lazy and degraded, still avail themselves of a miserable plough and the canoe of the Indians. In Brazil the structure of bridges is neglected even on the high road from Rio Janeiro to Villa-Ricca, and agriculture is carried on according to the model of the Indians. The forest is burnt down : they sow, reap, and abandon the land after a few harvests. The Brazilian peasant, especially in the central and northern provinces of the Empire, is both lazy and proud ; he despises labour as dishonourable, he cares little for habitation and dress, suffering rather from heat and cold. His religious ideas, his belief in wood-spirits and other spectres, is as absurd as that of the Botocudes. The children of the Portuguese settled in the Sertajo grow up indolent and become prodigal ; their farms fall into decay. Ignorance and superstitious belief in witchcraft, spectres, and amulets are universal ; they have lost all the dignity of human nature, and only pass from their apathy to the grossest sensuality. Though pacific and hospitable, they are devoid of any intellectual or moral activity. Women and gambling form the sole objects of interest, and there are here some few Portuguese refugees who have forgotten religion, the knowledge of the use of money, and even of salt.

'In Goyaz it is not much better ; the colonists are enervated by early excesses ; concubinage is so common amongst them that a married man is an object of mockery. Poverty is prevalent ; their indolence is remarkable ; fraud, especially falsification of the gold, is general. Something similar may be found in other mining and gold districts. The thirst for gold and labour is succeeded by wealth and prodigality ; then succeed enervation, misery, poverty, and all vices. There has, for a long time, existed in the islands Fernando Noronha a Portuguese criminal colony. No trace of agriculture is visible there, nor is any amelioration of their miserable condition thought of. The people smoke, gamble, or lie in their hammocks ; they have but a miserable ferry-boat, so that Webster exclaims in astonishment :—'Is it possible that these people are the progeny of the seafaring Portuguese, who were so eminent as navigators ?' In Africa the condition of the Portuguese is equally miserable. On the West Coast, where they settled in the sixteenth century, they have intermixed with the Negroes, 'and are pretty numerous; they live in forests; and it is their influence which obstructs the progress of the Siberia Republic among the Negroes. The indolence of the Portuguese on the east coast of Africa nearly equals that of the Negroes; their chief object is an existence which may be attained with the least possible effort. The horrors of their dominion and of their own degeneration are described by Omboni. In Angola, they have introduced no other agricultural implement but the hoe; and manioc, which affords but small nutriment, is still the chief vegetable aliment. The condition of the Europeans in the Banda Islands is but little better. Nearly all the Spanish and Portuguese Colonies rival each other in proving how little these nations are able to spread civilization in other regions; since, separated from their native country, they are not even capable of preserving the culture they have brought with them. The English and the French have, in this respect, proved more successful; but this superiority can only partly be ascribed to the superiority of the original stock, and to the care of the Government of their mother-countries to keep up the intercourse of the Colonies with the civilized world. Nevertheless we learn that, in the Mauritius for instance, the population of which is chiefly French, the condition of agriculture before the advent of the English (1810) was as bad as in the Spanish Colonies; ploughs were scarce, and the fields were not manured.'

Dr. Waitz adds:—'It may be objected that several of the instances cited referred to mixed populations and not to pure Europeans. Still it must be admitted that, even in these cases, the European blood, despite the improvement of the race which is usually ascribed to its infusion, has not proved its efficiency in raising the breed one step above the condition of the aborigines; and that even in such cases there was no intermixture, or a very slight one, the degeneracy of the population was nearly the same. The assertion that the European alone is capable of taking the initiative in civilization, and that the impulse thereunto is a peculiarity of the race, must, after the quoted facts, be considerably modified, for they prove, at least, that the white man is not much less dependent on external circumstances in his progress towards civilization than the black man. This is plainly shewn when we consider man in his individual capacity.'

In discussing this Spanish American Colonization question, it has always been considered that, in all probability owing to the strong interfusion of Moorish blood in Spain, the Spaniards,

like all the other dark Europeans, endure the heat of the tropics better than the white Europeans do. Colonel Flinter, long ago, observed that the Spanish soldier suffers less, and the British soldier more from the effects of the West India climate than those of any other nation. This, he considers, may be partly attributed to the climate of Spain being warmer than that of England. Judging by latitude, which, however, is not always a valid criterion, residence in Mexico ought not to be more trying to a native of Madeira than removal to Kamptee would be to a Sikh of Lahore.

In the present day, it is needless to devote much time to the argument that the increase of a mixed race in India would prove a failure both ethnologically and politically. Such races are never vigorous. Dr. Waitz shews that the half-breeds of Negroes, Indians, and Whites in Panama, are very prolific between each other, but cannot easily rear their children, whilst families of pure blood are less prolific, but bring their children up. The progeny of Chinese by Malay women in the East Indian Archipelago are said to die early. According to Dr. Yvan, the children of the Dutch and Malay women in Java are said to be only productive to the third generation. They are well developed up to the fifteenth year, when they remain stationary. In the third generation chiefly daughters are born, and these remain barren. It is also asserted that the children of Europeans in Batavia become frequently sterile in the second generation.

It was shewn in the *Calcutta Review* for September 1858, that,—while the respectable and provident portion of the East Indian community of Bengal are, at certain ages, subject to a less rate of mortality than that which prevails among any other class of Christians in India,—the mortality rate among members of the Uncovenanted Service Fund between the ages of twenty-six and fifty years was by no means favourable as compared with English rates, being 20·78 in the thousand. The mortality rate among East Indian ladies between the ages of fifteen and sixty-eight is higher, being 22·55 per mille.

The above facts and comparisons lead us to the conclusion that India comes fully within the category of those regions, which, permitting settlement, absolutely forbid colonization by Europeans. If it be considered a fact, proved on ethnological data, that it is physically impossible that our race should colonize India in the strict sense of the term, it, of course, becomes needless to waste time and argument in enquiring whether it would be either wise, humane, or profitable to attempt such a measure upon a national scale.

There can, however, be no doubt whatever that the extension of European *settlement* in India is one of the most interesting and important questions of the day. There is, undoubtedly, a great call for European settlers in India. And, with the assistance of native labour, abundance of profitable work lies before them in directing the clearance of jungle in Oudh and the Dhoon, in rearing cinchona trees on the slopes of the Himalayas and the Neilgherries, and in coffee and tea planting in Assam, Cachar, Darjeeling, and Kumaon. This measure, while it will tend vastly to confirm our power in India, will, strictly conducted, prove a large source of good to the natives of the soil, by the employment and agricultural teaching of multitudes of labourers, and by increasing the value of vast tracts of land which, at present, lie waste in the occupation of Zemindars. It is also to be borne in mind that the influence which is most inimical to the health of Europeans in India is the ill-distribution of trees and water throughout the country. Jungles and swamps are the main sources of Indian pestilences; the want of trees in the plains of Upper India, as barriers against the hot blasts from Sahara, was fully recognised and profitably remedied, for a time, by the ancient native rulers. By judicious clearing, planting, drainage, and irrigation, India may still be made what similar measures had rendered the lands of Babylon when Herodotus viewed them, the garden of the World, possessing a not disagreeable and tolerably healthy climate, in which European settlers may expect to lead industrious, pleasant, and happy lives in their plantations, sending their children home for education and re-invigoration, and calling them hither again, at full age, to become their successors in the land.

The men of England have been called to India by Divine mandate for many works, among which the systematic colonization of the country is not one. Industrially our mission here is to develop Indian enterprise, and to lay open the rich resources of the country. Morally, we are called upon to teach and civilize the people. To succeed as settlers in any land, we must first decipher from historic evidence those laws which the Father of All has legibly recorded for the governance of the dominant races when settling among rude and heathen people. The buccaneering settlers of ancient times neglected the true aims of colonization, and they reaped the fruit of their evil labours in disappointment and curses. We see Hernando Cortez in his progress towards Mexico, El Dorado acting like a magnet upon every sword-blade in his Company, coveting whatever he saw, grasping whatever he coveted,

exchanging collars of glass for armour and carkanets of beaten gold, burning the villages which refused to victual him, empowered only with the falsehood that to his master 'the monarchie of the universall did appertain,' and with the jibe that 'hee and his fellowes had a disease of the heart, whereunto gold was the best remedie.'*

About a hundred years later, we see Walter Raleigh going forth upon the same search for Mexican gold, professing, and probably with sterling truth, a desire to deliver the Indians from the tyranny of Spain, but ever intent upon 'the Star that directed him thither,—the great Guiana mine,' with utter disregard to the prior rights of the Spaniards, retorting upon those who accused him of piracy, 'Did you ever know of any who were pirates for millions? They only that wish for small things are pirates,' and, at the very last, encouraging his men with the cry, 'Come, my lads, do not despair. If the worst comes to the worst, there is the Plate Fleet to fall back upon!' Cortes sinks a heart-broken and disappointed man at the feet of the Monarch whom he served better than he served his God. Raleigh, beyond all comparison the noblest spirit of his time, ends that most brilliant and most disastrous career on a scaffold in Old Palace Yard, vainly attempting to prove to the gaping crowd that he had striven to live an honest man.

Certain lands have been, providentially, baited with gold, palm oil, diamonds, pearl-oysters, not that greedy men should flock thither, and, having filled their hands, their pockets, their chests, and their ships, return home to enjoy the profit or the plunder, but rather that, with the tide of trade, the wise, the pious, the educated, the largely humane should be attracted thither to spread among the people of the soil, whom their Father loves well, commerce, religion, civilization, agriculture, arts.

Thus England reads her duty in the present day, her religion and her policy alike teach her that the first principle of colonization and settlement is to render those subject nations for whom she legislates more virtuous, wiser, healthier, more prosperous, happier than they ever were before our standard was planted on their shores.

All revelation and all history combine in teaching us that the power of conquest and its inseparable attribute, the duty of civilization, are the Almighty's chief instruments in working out the moral and social advancement of mankind.

* Purchas, his Pilgrimage.

From age to age these have, manifestly, wrought together. Wherever the angel with the drawn sword has sped forth, the angel with the open book has followed—at an appointed time. Our rulers know and act upon these principles, let us who throng hitherward with our swords, our learning, and our arts, be careful that we do not forget them.

DIRECTIONS

TO BE ATTENDED TO

IN RECORDING CASES OF PRIMARY VENEREAL LESIONS

(EXCLUSIVE OF GONORRHŒA), AND THEIR CONSEQUENCES,

AMONG PATIENTS IN THE WARDS OF THE ROYAL VICTORIA HOSPITAL.

1st.—The term "Syphilis," or "Syphilitic," when used in the case-book, is to be applied only to such cases as are believed to be of a *specific infecting* kind; non-syphilitic venereal lesions are to be named according to their local and physical characters, as "superficial abrasion," *&c.** (see Note.)

Note.—* The position of the term "Syphilis," in the Classification of Diseases, is *Class I.* Zymotic Diseases; Order 2. *Enthetic Diseases.* The proper place in the Classification for all simple lesions on the penis should be *Class III.* Local Diseases; Order 6. *Diseases of the Generative System.* In the *numerical* returns of Army diseases, however, according to present arrangement, the designations "Ulcus Penis," "Ulcus Penis non Syphiliticum," and those of all other *non-infecting* lesions on the penis is ordered to be shown in the same class and order as the *infecting* lesions. (See Medical Regulations, 1859. Statistical Nosology, p. 150.)

2nd.—The following five points are to be noted in entering the history of each venereal case in the case-book :—

I. Physical characters, and exact site, of the lesion.
II. Period of incubation.
III. Character of attendant inflammation.
IV. Effects on neighbouring glands.
V. Prognosis.

3rd.—Under (I.) "Physical Characters and exact site of lesion," state whether,

(A) the lesion has the appearance of a papule: fissure: an abrasion: of a dry, or moist, open sore; whether, if a *sore* exists, it is superficial, not appearing to penetrate the whole thickness of the integument: or deeper, with a smooth surface, scanty, chiefly serous secretion, grayish in the centre; whether the texture around the lesion is indurated, and, if so, what is the character of this induration, especially whether it is circumscribed, cartilagenous-like, and appears to be distinct from the subjacent and surrounding tissues; or whether,

(B) an excavated sore exists, with abrupt defined edges, involving the whole thickness of the integument, with an uneven surface, covered all over with copious secretion, and without circumscribed induration.

Mem: The induration which exists from simple inflammation excited by the rubbing of clothes, the probability of which the site of the sore will perhaps indicate, or by the use of irritating applications, such as nitrate of silver, &c., and which disappears gradually in the surrounding tissues, must be carefully distinguished from the circumscribed hardness characteristic of the true syphilitic sore.

If more than one sore exist, it must be noted whether the several sores appeared together from the first, or appeared iu succession.

If some time has elapsed since the patient was first taken under treatment, the *original* form and appearance of the sore should be traced as far as possible and noted:—whether it began as a pimple, abrasion, fissure or otherwise.

4th,—Under (II.) "Period of Incubation," should be ascertained and stated whether

(A) the lesion first appeared after a lapse of one week, or from that time to a month, after exposure to contagion; or whether

(B) there was no period of incubation, the sore appearing within a week after exposure.

Mem: The importance to the patient of the questions at issue should be frankly explained to him, and his confidence secured, so that he may be induced to state as exactly as he can the number of times he has been exposed to contagion within a period of four or five weeks prior to his discovering the existence of the lesion. A patient usually himself dates the origin of the lesion from the time when he was *last* in the way of contracting disease. He may, however, have been in the way of contracting disease many times *after* the particular occasion on which he really contracted it.

5th.—Under (III.) "Character of attendant inflammation," state whether,

(A) the inflammation appears to be of the adhesive, or whether,

(B) of the suppurative, or phagedenic, kind.

6th.—Under (IV.) "Effects on neighbouring glands," state whether,

(A) the superficial inguinal glands are, on one, or both, sides, generally and separately indurated, the inflammation with which they are affected being of an indolent character and without pain; or whether,

(B) the glands are free from enlargement, or whether one or more of the glands are enlarged and exhibit a tendency to suppurative action.

7th.—Under (V.) "Prognosis," state whether you consider the case to be one of (a) syphilis, or (b) of local venereal sore, or (c) of a doubtful nature.

If the circumstances described under (A) exist, the conclusion will be that the lesions are indicative of the constitution being affected by Syphilis; if those described under (B) exist, the conclusion will be that the lesions are local.

If your prognosis is doubtful, state the considerations which cause it to be so.

If the prognosis that the patient is afflicted with Syphilis be correct, then the specific sore will not be capable of repetition on the same person by inoculation; if the prognosis be correct that the sore is a simple one, then the sore will be capable of indefinite repetition on the subject of it by inoculation.

If your prognosis is doubtful, regard the disease as local until further observation establishes a contrary condition.

The following brief instructions for the investigation and description of venereal ulcers, extracted from the "Science and Practice of Medicine," by Dr. Aitken, 2nd edit., vol. 1, page 705, are appended, as they appear calculated to elucidate still further the objects of the foregoing directions.

HINTS FOR THE INVESTIGATION AND DESCRIPTION OF SYPHILITIC ULCERS.

"1. Ascertain as near as possible the date of contagion, "keeping in view the media or vehicles of contagion, in "addition to virus from a true primary chancre—namely, "from ulcers in acute secondary syphilis; from the blood "of patients suffering from acute secondary syphilis; from "mixed chancres carrying the virus; from sloughing sores "carrying the virus.

"2. Examine the patient, keeping in view,—

"(a.) That the soft, 'non-infecting' sore commences "almost immediately (*i.e.*, twenty-four hours to within "three days after connection). It commences as a red spot "or a point, passing very soon into a pustule and soft "suppurating sore.

"(b.) That the 'infecting' sore does not commence "before the end of the second or beginning of the third "week (eighteen to twenty-four days); and if the disease "has been contracted from a secondary ulceration not before "the expiration of the third or fourth week (RINECKER). "A specific sore results in the form of a papule, abrasion, "fissure or crack; the formation of pus, or an ulcer dis-"charging pus, being an accidental occurrence.

"3. Examine microscopically the discharge from all "syphilitic sores, keeping in view (1.) That a 'soft, non-

"infecting" sore discharges pus cell; (2.) That the fluid "discharged from an 'infecting' sore is not pus but a mole-"cular debris.

"4. The irritation of an 'infecting' sore may cause it to "discharge pus, along with the 'infecting fluid.' Hence "mixed chancres."

"5. The soft, purulent, non-infecting sore may be trans-"planted at will, and at any time, on the patient's body. "The true 'infecting' sore cannot be multiplied after "glandular enlargement and general infection becomes "developed. It remains a solitary sore.

"6. Look every day for cutaneous eruptions during the "existence of a primary sore.

"7. Examine the lymphatic glands—not only in the "vicinity of the chancre, but also those in the axilla, and "the neck up to the occiput. Note as to the slowness or "rapidity of the enlargement—hardness or softness—ten-"dency to suppuration, and whether painful or not.

"8. Nomenclature to be especially attended to; as above noticed."

Some of the patients admitted for primary lesions at Netley have been previously for some days, sometimes three or four weeks, under treatment elsewhere. It becomes therefore very important that each of such patients should bring with him a complete and accurate statement of the history of his disease, its treatment, and course, up to the time of his leaving the the medical officer from whose care he may have come.

The following form of return was received with patients sent from the 6th Brigade of Royal Artillery at Portsmouth. As this return embodies all the information of this nature which can be required by the surgeon to whose care the patient has been passed on, and supplies this information in a form calculated to abridge writing and at the same time to check omissions, it is considered useful to insert it here. The form is also suggested to be one, which, with one or two additions which will readily occur in use, would be a convenient one for the tabulation of observations by Medical Officers on cases treated throughout their whole course by themselves.

REGIMENT

Nominal Return of Men of the above Corps affected with Primary Venereal Lesions (exclusive of Gonorrhœa) and transferred to (Place and Date) Hospital for further treatment.

Regimental No.	Rank and Names.	Age.		Service.		Date of Attack. (Probable.)	Precise seat of disease, and whether first attack of Primaries or not.	Interval between date of Contagion and appearance of sore. (Probable.)	Character of Sore.	Condition of Inguinal Glands.	Previous Treatment.	REMARKS.
		Years.	Months.	Years.	Months.							

(SIGNATURE.)

TREATMENT BY MERCURY.

Mem.—It is not intended in these memoranda to enter into the whole question of treatment, but merely to add a few directions in respect to employment of mercurial remedies.

1.—Mercury, with a view to influence the constitution, is not to be given in cases of primary lesions; but if secondary evidences of syphilitic taint appear, mercury may then be judiciously administered to assist in the eradication of the disease.

If the primary disease be true Syphilis, mercury cannot prevent the patient from becoming constitutionally tainted: the local lesion appearing after a period of incubation is as much a manifestation that the constitution is already affected, as is the developed vesicle of variola vaccina a manifestation that the constitution is affected with variolous poison. Experience shows that secondaries follow the specific lesion even though the patient may have been previously salivated. If the lesion be not *syphilitic*, then mercurialization of the patient will not assist in its cure, and will be hurtful to the man's constitution.

2.—The earliest secondary manifestations are usually affections of the skin and mucous membrane, and these appear to be indications of a natural effort to get rid of the specific poison through excretory organs. At this period the administration of mercurials is calculated to be useful in assisting the natural process just described.

3.—The mercury is not to be given with a view to produce salivation. The object is to bring the constitution gradually and gently under the influence of this remedy, Mercurial vapor baths, prudently used, answer this purpose most fully; the remedy thus administered does not seem to injure the constitution of the patient, and the action of the skin which is excited during the employment of the vapour bath is additionally beneficial.

4.—In the cases of *Invalids* arriving with Secondary Syphilis, mercury is not to be given under any circumstances on their first arrival at Netley. The constitutions of the patients for the most part are already broken down under the effects of climate, perhaps of former intemperance, of previous treatment, and of a long voyage during which salt rations have probably formed a considerable portion of their food. Mercury, if administered under these circumstances, will only aggravate their cachectic condition. The worst cases of Secondary Syphilis are generally brought by those vessels from which also scorbutic cases arrive. The general strength of these patients must be first re-established by proper hygienic arrangements, nourishing diet, and tonic remedies, and then the propriety of attempting to eradicate the syphilitic virus by the use of the mercurial vapor baths will have to be considered.

THOMAS LONGMORE,
Deputy Inspector General, Professor of Military Surgery.

Army Medical School, Netley,
April, 1864.

J. J. Bennett, Machine Printing Works, 143, High Street, Southampton.

[*Published in No. XVIII of the Indian Annals of Medical Science.*]

THE STATION OF MOOLTAN.

BY
ASSISTANT SURGEON R. T. LYONS,
BENGAL ARMY.

1. Mooltan, a town famous in Indian history for the rebellion in 1848 of its native ruler Moolraj, the assassination of two British Officers under peculiarly painful circumstances, and the operations for its reduction, is a military post of great and increasing importance, and is garrisoned by a large force. Its importance is mainly derived from its position, being in the neighbourhood of turbulent and warlike independent States, and not far from the frontier of British territory in the Punjab. Under its native chiefs, it was a place of much greater significance, apart from military considerations, than it has been under British dominion. The trade of all parts of the West of India, and from Afghanistan and Persia, flowed to it. It was a great emporium of commerce, and the seat of many valuable native manufactures, which have since declined. It is not unlikely that, ere long, it will recover some part of, if not surpass its ancient commercial importance. Its position on the high way from the North-west and the Punjab to Kurrachee will, on the completion of the Railway, throw into it the immense trade of Upper India; while the increased influx of Europeans will add not a little to its future prosperity. The latter probability, together with the fact of the contemplation by the Military authorities to increase the number of the European portion of the garrison, invests the station with no small share of medical interest, apart from purely commercial and strategetic speculations.

2. The traveller proceeding to Mooltan passes through vast tracts of arid uncultivated districts, relieved at distant intervals, "few and far between," by small mud villages, surrounded by scanty and meagre fields. The wildness and soli-

tude of the country increase as he progresses—the small fields dwindle gradually into smaller, until he approaches the old city, when vegetation re-appears with a luxuriance and profuseness which falsifies his anticipations. While, hitherto, he has beheld nought but meagre crops, stunted trees, parched grass, and the wild thorn, he now views stretching before him groves of tall date trees and sissoo, magnificent pepuls, and other lords of the vegetable world and far spreading fields. Strangely contrasting with this fresh luxuriance lies the hoary city in the midst of it—a huge pile of grotesque mud houses, with quaint stories and diminutive windows and balconies, of many domes of mosques and shrines dedicated to heathen deities and saints, and innumerable tombs of the ancient dead, preserved to this day by the piety of the living. Companion to the city is the old fort of Mooltan, now a miserable ruin, but the height and massiveness of its crumbling bastions still convey to the mind of the beholder a sense of its former strength and impregnability. An excellent carriage road, lined by fine trees, with a raised foot-path on the sides, leads to the Cantonment, about three miles distant from the city and fort. The approach to the Cantonment is beautifully marked by a row of pretty cottages, with neat grass plots and tidy flower beds. The Cantonment is situated on an extensive open plain, somewhat higher than the level of the city. It is well laid out, without regard to extent of ground, and covers an area of about two square miles, of which the larger portion is devoted to the European troops. The eastern or European section of the station differs in its natural aspect from the western section, which is appropriated to the Native troops. Somewhat higher, and for the most part almost destitute of vegetation, it appears to have been selected for these qualities for the quartering of the Europeans, while the western section, lower in level, with a firmer soil and more vegetation, a spot more pleasant to look upon, has acquired the reputation of unhealthiness. The dreary uninviting aspect of the station is in marked contrast to the rich and luxuriant country in its neighbourhood.

3. The dreary aspect of the Cantonments generally has no doubt struck many on their first entrance into the Punjab—this feature like some others being less noticeable by those who, from long residence, have become habituated to it. It may not, perhaps, be without utility to allude to the opinions

that appear to have led to the origin and perpetration of this most extraordinary characteristic. The association of vegetation with the production of miasm, and hence of disease, is probably the foundation of it. That the English, who themselves come from a highly cultivated and in parts richly wooded country, a country which is by no means unhealthy from that condition, and to which they return in search of health, should here in India connect trees and vegetation generally with the causes that produce disease is an incomprehensible inconsistency. Flora is shorn of the benign qualities assigned to her by the classics, and invested with the deadly attributes of the Hindoo Káli. Science does not give countenance to the view that vegetation is a source and fomenter of disease. The beautiful theory of the Chemists, on the contrary, pointedly assigns to trees the office of the purification of the atmosphere. The Botanists claim for the interesting objects of their study other kindly and beneficial functions, the object of which is the adaptation of the atmosphere to the varying requirements of the animated creation. The Hygienists, following in the wake of these pioneers of their art, do not condemn them. The general sense of mankind apprehends their utility. That a wild tract of country, abounding in a rank exuberant vegetation, is probably pestilential, is conceivable and within experience—but to attribute to this living vegetation the sole causation of the morbific influences, and to abrogate as sources of disease the conditions that produce such excess of vegetable life, is a gratuitous presumption. The fact of the coincidence of prolific vegetation and miasmatic influence, as well as the principle of practice that has been founded upon it, has been stretched to too great a length, and acted upon apparently without qualification or limit. The established fact that a profuse and gorgeous vegetation, covering a large area of country, that flourishes on the rotting remains of generations of predecessors, and has never known the controlling hand of man, sustains an atmosphere pregnant with deadly disease, has ostensibly led to a belief that every individual tree is a centre of malaria in a proportionate degree, and that every blade of grass supplies a whiff of poison. Flourishing vegetation is interpreted to be a sign of the existence of causes of diseases, however opposed other local conditions may be to such an indication. To the Indianized military mind, the treeless desert is the locality best adapted for the site of a Cantonment. Man, says the physiologist, cannot flourish in a region where a plant has not preceded him. The Indian General erects a station in a situation where vegetation struggles for existence, and where crows with difficulty peck up a precarious living. If bountiful Nature, never too parsimonious, yields a blade of grass, or a solitary tree, the ruthless care of the General destroys her gracious gifts.

4. This notion regarding vegetation would seem, however, to be purely an official one, and hence appears to have more influence in the arrangements for the soldiery than for the Officers. While the site of the barracks is generally bare and cheerless, and while a tree is not tolerated in their neighbourhood, a greater latitude is permitted in the lines of the Officers. The dismal desolation surrounding the men presents itself in jarring contrast with the tree-encircled and gardened quarters of the Officers. This anomaly in itself is a strong argument that the notion is ill-founded and has not obtained much belief. For why should the Officers who study, think, form conclusions, and legislate for the men, whose most anxious endeavours are for the welfare and health of the soldiery, and who are equally interested in their own well-being, strictly follow a rule in the one case where officialism prevails, while they widely depart from it where they themselves are privately concerned. Such is the influence of officialism on the minds of men, that the very individuals who delight in pleasant places, who beautify their residences with grass plots and flower beds, who do not hear stealthy footsteps of pale death in the pleasant rustling of the trees around their houses, conscientiously and in good faith consign the soldiery to cheerless desolation.

5. The natural desire of civilized man to surround his dwelling with the beautiful objects of the vegetable world is needlessly and foolishly suppressed in the heart of the Indian Soldier. One of the most innocent and refining of pleasures is causelessly denied to him. Withholding the absurd idea of unhealthiness, no rational objection can be urged against allowing the same latitude to the Soldier that is permitted to the Officer. Sufficient ground being left for parade and drill, the space in the immediate neighbourhood of the barracks, instead of being as now a dead blank, weighing down the

spirits of the men, may be tastefully laid out in flower beds, and even planted with trees. The Officer loves to have his flowers close at hand to delight him always with their beauty, and to be a tasteful adornment to his home. It is presumed that the Soldier has the same feeling, and would prefer to have his garden around his dwelling, rather than half a mile off, or at whatever distance the sages consider danger-range. The scheme of Soldiers' gardens would, perhaps, thrive better, and become more popular with the soldiery, if the utilitarian principle involved in it ~~could~~ be more loosely drawn; if it ~~could~~ be modified to the level of the object of the private gentleman in stocking his garden, or of the Railway porter in rearing his flower beds. While the garden would not the less be a means of agreeable and healthy occupation to many of the men, it would effect a great and pleasing change in the prosaic aspect of barrack existence, and be a source of ever-present pleasure and delight to all. Barrack life needs a few flowers and roses to enliven it. The garden scheme partakes much of the character of agricultural speculation, in which material returns and profits occupy a large share of the inducement held out to the troops for their laborious recreation. The Soldier considers that good vegetables in sufficiency form a portion of his rations, to which his right is established, and that no labour on his part should be necessary to supplement his dues. The stolid Soldier is unable to draw the line between the occupation offered for his recreation, and a labour by which his rights are seemingly earned twice over. The present garden scheme would prove far more beneficial to the Soldier in India, if made compulsory, as many analogous occupations are made compulsory on the army in England, than if left as now to voluntary prosecution by the men. But if compulsion be unadvisable, as for weighty reasons it is, a less prominence given to substantive returns from the voluntary labour of Soldiers in gardens, and the scheme modified to the extent of encouraging the production of ornamental environments to their barracks, would perhaps be more readily embraced by the army in India, and provide for the men that agreeable occupation benevolently desired for them by the Commander-in-Chief.

6. Another characteristic of stations is the utter want of artistic design and decoration in the military buildings. Constructed according to no recognised style of architecture, the

long lines of shapeless blocks of barracks add to the sombre dismal appearance of a locality in itself unprepossessing. The neglect of the fine arts, a sad feature in the history of the English in India, is perhaps as greatly marked in the hideous habitations which they have devised for themselves and their army, as in other departments. From Calcutta to Peshawur, through an immense region of some two thousand miles in extent, many years in our possession, studded over with countless Military stations, and garrisoned by a vast army, not one Military building has been erected worthy of the genius of the nation, or adequate to stand a typical recognition of the deeds of a glorious army. Sanitary considerations and climatic peculiarities offer no hindrance to the employment of architectural embellishment. An unique style of structure differing from that prevailing in temperate regions may perhaps be appropriate to a country of the temperature and variations of seasons experienced in India: but these circumstances do not preclude the patronage of the amenities of architecture, and the addition of artistic graces to a structure in all respects apposite to the climate. By the character of our Military stations, as much as by other means, can our superiority, other than warlike, be rendered apparent and brought home to the inhabitants of our vast provinces. In the depths of the Mofussil, the Cantonments are perhaps the most vivid evidences of our occupation of the country, and it is from them in great measure that myriads of the native commonality derive their conceptions of the parts and qualities of their English masters. Necessitated as we are to multiply these stations, it may not be an idle consideration to render them sources of moral influence on the natives, and additional means of increasing their respect for our national genius. The field for the culture of artistic and architectural talent, in this country exceedingly limited, may in these stations be enlarged to a certain extent, to the social advantage of the general community.

7. Independently of the motives above cursorily alluded to, it is a matter of no slight importance to endeavour to mitigate the rigour of long residence in an uncongenial climate, and in some measure to allure the partiality of troops to service in this country, by efforts to render the stations of the army, and the barracks of the soldiery not only healthful, but likewise to a certain degree picturesque and attractive abodes. The present hideous warehouse-like structures add not a little to the *malaise* and fretfulness which the soldiery naturally, from the peculiarities of Indian existence, experience during their sojourn in this country. A more pleasing dwelling would effect to a partial extent a passing compromise between life in India and at Home, and in some minor degree conciliate the Soldier to the social privations and severities of existence in this country. Even retaining the prevailing principles of barrack building, which, it may be presumed, the experience of a century has deduced to be the best adapted for the attainment of health in this climate, certain architectural devices may be aptly introduced, which, without reducing the sanitary qualities, or even departing from the principles on which the barracks are built, may take from them some shades of the hapless and gloomy mannerism so peculiar to them. The strict austere working of means to an end, the construction of a durable habitation merely for shelter from the elements, to the suppression of other considerations, would appear to have been the single absorbing object of the designers and builders of the ugly domiciles of the army. The stalking massiveness of the bastion, the grotesque *tournure* of the powder magazine, the barren symmetry of the rampart, has each its character marked upon the features of these hideous buildings. The ordinary embellishment of an ordinary house, the simplest and meanest graces of architecture, are religiously proscribed, either as deadly to the health, or enervating to the morality of the Soldier.

8. The æsthetic defects of Military buildings do not appear to be confined to the barracks alone, but are likewise observed in the construction of the churches, chapels, and hospitals of a Station. There are, however, a few station churches, which, could the charm of antiquity be thrown over them, would appear to our forgetful eyes as picturesque and beautiful as the parish churches in our fatherland. But there are others which, but for the cross over them, the heedless spectator might mistake for expense magazines, or granaries, or for buildings devoted to any purpose but the worship of the Creator. Far more than the dwellings of the living are the homes of the dead denied the softening resources of art. No whispering trees overshadow the resting places of the departed; no grassy walks guide the mourner to the neglected grave of

the dead comrade or child. The vilest weeds of the jungle grow rank in the cemetery, and luxuriate over the forlorn beds of the forgotten sleepers.

9. The ornamentation of Stations generally, and of the quarters occupied by the soldiery, is a subject to which greater attention may be paid with advantage to all concerned. As man cannot live by bread alone, neither can he enjoy existence, or reconcile himself amiably to his position, in a habitation which affords him merely rest and shelter. It is a saving tendency common to all men, savage or civilised, gentle or simple, to blend the beautiful with the useful, in all the concerns and requirements of life. Nor can the beautiful be said to be without its use, for the mind, cheered and brightened by the contemplation of the beautiful reacting on the body, stimulates and invigorates its functions to healthy action. Is it possible to conceive that the health and physique of the Soldier would not benefit by changing his landscape from arid barrenness to foliage and verdure, and his dwelling from hideousness to a more graceful and elegant configuration. With a more attractive home, station, or barrack, in addition to other received benefits, the fretfulness and disaffection of the Soldier sojourner with the uncongenial country and its belongings, would abate in some degree, and the yearning to flee would be felt in less force. And how much a placid satisfied mind induces to improved health is within the knowledge of all men.

10. The above remarks are specially applicable to the Cantonment at Mooltan, and more particularly to the European section of it. The existing arrangements of the Stations date from the mutiny of the native garrison in 1857. The site of the present barracks was formerly the lines of a Native Cavalry Regiment; and, in effecting the change, an extensive destruction of trees appears to have been made. The removal of a large number was inevitable to clear the ground for the erection of the new buildings; but a much larger number than was necessary for this purpose would appear to have been destroyed, apparently under the mistaken idea that their proximity would interfere with the open air ventilation, and prove a source of disease. The neighbourhood of the European barracks has, in consequence, acquired a bare desolate appearance, peculiar to itself, in a locality more remarkable for fine, leafy, umbrageous trees, than perhaps any other in

the Punjab. The greatness of the loss can be judged from the few noble trees that have been spared, which form a delicious shady grove in a wilderness of dust and grim red-brick buildings. Nor has any endeavour, till very recently, been made to replace the trees that had been destroyed. It was originally designed that the Soldiers' garden should be planted close to the barracks. Plots were marked out, and the plan was approaching completion, when an official objection appears to have interfered with the conversion of a desert into a garden. It was gravely urged that the irrigation of the gardens would loosen the soil, and undermine the foundations of the barracks. The force of this objection, *per se*, or combined with the current notion that vegetation in general is unhealthy, prevailed, and the garden scheme was abandoned. It is barely necessary to observe that several private houses have irrigated gardens around them, without sustaining any appreciable damage to their foundations.

11. One cannot reflect on these proceedings without the sincerest regret. The locality is admirably adapted for the production of splendid trees, which thrive well, and in a few years increase to a magnificent size, scarcely attained elsewhere. The want has been latterly perceived, and the Officers of the Bengal Fusiliers, during the last year of their residence in the Station, extensively planted young trees on the grounds between and around the barracks. The two large swimming baths attached to the barracks afford an abundant supply of water, which would be better utilized in watering these trees than in being allowed to stagnate in drains that do not drain, and to inundate and destroy the public road. The supply of water from the waste of the baths, and from the large wells that fill the latter, is very abundant, and sufficient to meet the requirements of a large garden or lawn. The cultivation of grass around the barracks is also well worth attention. The grass of Mooltan, though not a spontaneous production throughout the year, is capable of being reared in the hottest months. It is a short narrow-bladed variety, soft and velvety, and of a remarkably rich verdure. Few objects of nature in Mooltan are more grateful and refreshing to the sight than the beautiful grass-plots reared in some of the private compounds, within and beyond the limits of the Cantonment. Even the Jail possesses a few neat and highly ornamental belts of turf within its walls. A moderately sized lawn has

been for years maintained, green and fresh, in the private residence of a Staff Officer of the Station. With the large supply of water close by, and the willing industry of the Soldiers, (for there is no doubt that it would be cheerfully given,) the facilities for growing grass plots around the barracks are immense. One can scarcely adequately figure to the mind the depth of aridity and utter bareness around the European barracks. On all sides is a dry dusty space, unrelieved by a visible green object. A single plot of verdure would make an agreeable diversion. A zone of grass all around the barracks would effect an immense change in the whole aspect of this portion of the Station.

12. The quarter occupied by the Officers of the garrison is a degree less dreary than the men's. The houses, however, are miserable mud-built structures, (with few exceptions), standing in the centre of an enclosed area, called a "compound." Most of them are wretched hovels, a fraction of a degree superior to the houses of the Natives. They have neither elegance of appearance nor durability to recommend them. Not the smallest particle of taste or architectural skill could have been possessed by their designer. Here also in general is a want of vegetation. The Mall, however, which traverses the more distant portion of the Officers' quarter, greatly redeems the appearance of this portion of the locality. It is a fine broad drive, lined on both sides with tall and elegant trees, which are highly ornamental. A magnificent peepul at the beginning of the Mall, near the target practice ground, is one of the finest to be seen in this part of the country. Tradition assigns it an ancient date, and the honor of having sheltered the tent of the Macedonian Conqueror. Whether the story be true or not, the dignity and stately majesty of the aged tree well become the association. Here also are the public gardens, supported by contributions from the Civil and Military community, and an excellent private garden and small lawn; the latter the more noticeable from being the only green spot to be seen within the Cantonment throughout the year.

13. A stranger would in vain look for the Station Church, if he expected to behold a structure on the plan usually adopted. The Church is a low-looking barn-like building, too mean to be called modest, and thoroughly unbecoming

the purpose to which it has been devoted. The Roman Catholic Chapel, so called, is a desolate barrack or unused Native hospital at a remote end of the Station. The Cemetery is a melancholy enclosure of weeds and graves. The grim lines of barracks, the unique-looking European hospital, and the fields of dust all around, do not raise pleasant sensations in the mind of the spectator.

14. Like several other localities in the Punjab, it is probable that the site of the Military Station of Mooltan was formerly the bed of the river Chenâb, which, in the present day, flows about four miles distant. The soil has much of the alluvial character, a dark clay, with a remarkable absence of stone, and some degree of intermixture with organic matter. During the hot months, the soil readily yields its surface moisture, and hardens into a firm crust, which ultimately crumbles, when completely dried, into a dark penetrating minute dust, which is readily elevated by the winds. The fall of rain, and at the close of the year, when the dew-fall is appreciable, it absorbs moisture and becomes less liable to be raised in clouds. Though possessing a fair intermixture of sand, the soil during the rains becomes dense and tenacious, acquires a smooth glistening surface, and is almost impermeable to water. A marked and striking peculiarity is observed in the soil of Mooltan during the prevalence of rain. The ground, previously known to be firm and solid, becomes, after a fall of rain, unstable and full of small pitfalls, although the surface is unbroken, and perhaps covered by a sheet of water. The peculiarity is probably owing to its clayey character, its great hygrometric capacity, and the singular adhesiveness which the presence of water imparts to it. The upper layer, a few lines in thickness, rapidly absorbs the rain-fall, increases in bulk, swells and rises irregularly above the lower soil, which is prevented from wetting by the impermeability of the raised surface. The elevated layer is of sufficient tenacity to maintain its new position, but is not capable of bearing any considerable weight. This peculiarity is commonly observed in the extensive parade ground, in which the dry surface, during the hot weather, is triturated by the constant exercise of the troops into an excessively loose dust, and thus acquires the condition best suited for the foundation of the tenacious upper layer. When the elevated surface dries, after the cessation of rain, it cracks in innumerable

directions, and ultimately sinks again into contact with the under soil, and crumbles into an impalpable dust. This peculiarity adds much to the difficulty of the surface drainage, as it operates greatly to the formation of inequalities of the soil, and the production of extensive shallow basins for the accumulation of the rain-fall. The qualities of the soil, and its behaviour under the influences of wet and heat and winds, necessarily exaggerate the difficulties of drainage, in all circumstances considerable in India. Where the level is always rendered inconstant by the peculiarity alluded to, a permanent drain often becomes useless for conveying away the surface collections of water. The plan sometimes adopted of spreading loose soil on the site of a pool of water observed to form after rain, so as to raise the level, is merely a temporary remedy, as the raised surface in subsequent rain-falls itself becomes the bed of a sheet of water. Small temporary trenches, in addition to the employment of earth to raise the level, so as to draw the collections of water as they form into the main drains, are probably the only means of remedying the formation of the extensive pools of water that collect during the rains in various parts of the Station, to the detriment of the health and convenience of the residents. The friability of the soil from the intense heat of the summer aggravates the difficulty of preserving the main drains in a working condition, for their sides readily fall in; while their channels are obstructed and the fall altered in parts by the gradual accumulation of masses of dust that are moved by the winds. The smallness of the rain-fall is, however, a happy mitigation of the great inconveniences that would otherwise result from these difficulties.

15. The readiness with which the surface soil of the district parts with its moisture, and spontaneously crumbles into a light dust, under the force of heat and in contact with a dry atmosphere, renders it peculiarly apt to be raised in clouds during the prevalence of gales. The dust-storms of Mooltan are notoriously the plagues of the Station, and intensely aggravate the misery endured during the burning summer. At all times in the hot weather, where the ordinary winds are not broken in force by buildings or trees, singular whirls of dust are elevated into the air, wherever the soil lies loose. A mass of dust is blown from the surface, and whirled upwards in a series of circles, which gradually acuminating as they rise, attain the height of several hundred feet, and are lost to the sight in the upper air. In high winds a very formidable quantity of loose dust is thus caught up, and dispersed through the atmosphere. When the force of the wind is considerable, and approaches to the strength of a gale, a remarkable natural phenomenon is produced, common to the clayey plains of the Punjab, to which the expressive term of "dust or sand storm" has been applied, as it derives its peculiarity from the clouds of dust which the storm sets in motion. A dust-storm can be predicted only a few hours before its approach. On a hot sultry day, an ominous stillness creeps over the atmosphere; the trees, whose light foliage is agitated by the gentlest current, gradually subside into motionless repose; the birds of the air, overpowered by the intense heat, or subdued by the sense of impending calamity, abstain from bold and lofty flights; imperceptibly the light of day wanes into a cloudy haziness. In the distance looms a broad lurid expanse, spreading from the earth to the sky, as if the air had put on a visible form. Majestic in attitude and volume, the gigantic dust cloud approaches in silent grandeur, imbuing the imagination with a sense of awe. Seemingly rooted in the distance, but moving with great velocity on the wings of the wind, the ocean of suspended soil advances swiftly, and its arrival is speedily announced by rushing precursors of dust. The obscurity is suddenly deepened; the air is overwhelmed to saturation with dense volumes of floating dust. The stillness is broken by the fierce soughs of the frantic winds. The battling of the winds, the wild sweeps of the agitated air are visible in the moving masses of dust. The previous calm is rudely dissipated by the stormy disturbance produced. Every object opposed to the passage of the billows of dust is covered with a thick deposit of finely sifted soil. The residents close every door and window, but cannot exclude the admission of the minute particles. The duration of the storm varies from a quarter to half an hour, though occasionally for an hour or two after the departure of the dust cloud, smaller gales continue to pass in its wake. The immense amount of dust dispersed through the air quickly subsides or is blown away to more distant localities. The atmosphere, after the passage of the storm, becomes comparatively mellow and clear, and there is a sensible mitigation

of the intense heat that prevailed, and a relief to the feeling of oppression experienced before.

16. The clay soil of the Station appears to be of considerable thickness, and water lies at a distance from the surface, as is evident from the great depth of the wells. The stratum under the immediate surface possesses the quality of clays in general of retaining a large amount of moisture: and it is, perhaps, from this character that the esculent bulbs of the potatoe are so liable to rot in this district. The water for drinking, culinary, and other purposes, is derived from deep wells, of which there are several in the Station. The supply from this source is not, however, very abundant, nor do the wells yield a steady complement for a continued period. Many of them, from causes not ascertained, dry up after a few years, and few, if any, of these are ever again capable of being brought into use. Nor do they all yield a supply that can be employed for drinking, from the large amount of saline matter permanently fixed in the water of some wells. The water from all the wells is more or less impure and unpleasant to the taste, but is capable of being rendered more agreeable to the palate by filtration. Water, however, abounds in the numerous canals and cuttings and in the large river that flows through the District. The water from this source is muddy, and is said to contain much saline intermixture. The Cantonment derives no supply from these sources.

17. The great characteristic of the climate of Mooltan is the fiery heat of the summer. All its other peculiarities are minor in comparison with this. The antique importance of the City was the origin of many traditions respecting it, which have been handed down to the present age. One of these attributes the terrible heat of the locality to the curse of a religious mendicant. The story is too absurd to be credible, but it not unnaturally leads to a surmise that a minor degree of heat to that which now prevails existed in ages long gone by. The supposition is by no means so improbable as it may at first sight appear. There is a strong presumption, that slow changes in the natural and artificial aspects of a country in the revolution of centuries are accompanied by alterations in the local climate and aerial phenomena, at first slight and imperceptible, which, accumulating in a long succession of

years, eventually consummate a sensible change. The probability of some marked difference having occurred between the ancient and modern climate of Mooltan, as well as of other districts in the Punjab, is strengthened by the evidences of terrestrial change observed in many localities, by the well known proclivity of the great rivers to alter their channels and dimensions, and the presumptive surmise of a diminution in the extent and degree of the spontaneous growth of vegetation and of agricultural cultivation. Within the last few years, it is stated, that an improvement has been experienced in the climate of the Station. The temperature is said to be less than it used to be some years ago, and the dust-storms are fewer in number. This improvement is attributed to the extension of cultivation in the District.

18. The heat of the climate extends during the period intervening between the close of the month of March and the close of the month of September, gradually augmenting towards the middle of the year, and attaining its maximum in the months of July and August. A sensible decline is experienced in the month of September. Becoming oppressive almost with the rise of the sun, the heat of the day steadily increases with the hours, and towards the fall of the afternoon reaches its degree of greatest intensity. The setting of the sun is followed by a lessening of the heat, but the subsidence is gentle and limited, and the temperature of the night air is but a few degrees lower than that of the day, when protected from the direct influence of the sun's rays. For the major portion of the hot season the warmth of apartments differs but little at day and at night. Removed from direct exposure to the sun, the atmosphere may be regarded as of tolerably uniform temperature throughout the calendar day, and the differences of rise and fall gradually and insensibly glide into each other. Towards the decline of the summer, a more marked difference occurs between the degrees of temperature prevalent during the day and night. While the day retains a steady temperature, the night air cools with some quickness, and towards early morning a considerable fall of temperature is experienced. The uniformity of temperature which hitherto existed is lost from the more speedy and abrupt subsidence of heat at night, and a wide disparity is felt between the temperature of the early morning and of the day before the meridian.

19. During the period intervening between October and February, the heat of the sun is temperate and agreeable, and the nights acquire a degree of cold that renders artificial warmth acceptable. To many the temperature of the day is chilly, so that fires are often lit in apartments even during the day-time. The temperature during the cold weather is delightful, conjoined as it is with a clear mellow atmosphere, and an unclouded sky. Out-door occupations and recreations may be now pursued throughout the day, without risk to health, and without the tropical discomforts attending open air exercise. Ice is manufactured by exposure of water in shallow basins to the cold of the night air, during this season.

20. Intimately associated with the heat, and maintaining always a steady proportion to it, the light of the day at Mooltan is of great brilliancy. In a perfectly clear atmosphere, and in a sky singularly unobscured, no ray is intercepted or absorbed in its passage from the sun. During the season of intense heat, the day breaking in the small hours of the morning rapidly advances in brilliancy into a blaze of illumination, which declines gradually and insensibly with the descent of the sun, and late in the evening is abruptly obscured. There are no natural objects, fortunately, which intensify or reflect the light, while the sombre colouring of the soil, and the verdure of foliage or turf, where these exist, afford a happy mitigation to the vivid brilliancy of this light. The gratification derived from the sight of a bed of grass, or a flourishing tree, is probably connected with the relief obtained by the eye, wearied with the glaring light. From this cause, possibly, independent of its rarity, is the spectacle of a grass-plot at Mooltan so singularly agreeable. In the fall of the year, and with the decline of heat, the day light wanes in brilliancy, and equals the moderate light prevalent in temperate regions.

21. The air of Mooltan is clear, dry, and of great tenuity. These are properties derived from the intense heat prevalent during the greater part of the year. The rarifaction of the air is indicated during the hot hours of the mid-day by two irregular undulations perceptible in the bright sun light, and by a vitreous appearance of the distant atmosphere, approaching the ocular illusion of the mirage. Its avidity for moisture is considerable, and exercised universally and incessantly. All substances rapidly yield their aqueous element to the

insatiable thirst of the atmosphere. Fabrics wringing wet are readily dried in an hour; leather and paper pass into a state of curling crispness; wood splits from complete loss of moisture; paste and size lose their adhesive quality, and are of little use in keeping together the parts of household furniture. Its effect on the tenacious clayey soil has already been noticed; the houses, which are mostly built of this material, are disfigured and weakened by long lines of cracks in their mud walls, the consequence of extreme dryness; while their clay roofs become imperfectly water-tight. Vegetation, not watered by artificial irrigation, withers and falls into the sere leaf.

22. The capacity of the atmosphere for moisture naturally diminishes during the cold season; its decrease is not, however, considerable, but is sufficient to obviate the great and continued inconveniences experienced in the summer. The warmth of the sun during the decline and renewal of the year still suffices to impart to the atmosphere the disposition to absorb a large amount of aqueous evaporation.

23. Considering the volume of the river, and the number of canals existing in the district, and the great escape of water from every substance capable of yielding it, the amount of aqueous vapour suspended in the atmosphere at Mooltan must be absolutely very considerable. The amount is, however, far short of even moderate intermixture, and is certainly not of sufficient bulk to produce any appreciable counteraction to the power of the sun's rays, or to effect material and continued variations of the atmospheric temperature. Clouds rarely appear. Almost uniformly throughout the year the sky is clear and unobscured, or shows but a few light and aerial cirrhi floating in the far distance. Rarely are the heavens overcast by heavy rain clouds. As in the Punjab generally, the rain-fall at Mooltan is very small, nor is the period during which rain continues of such duration as to be considered a season. The monsoon, so regular and continuous in the Peninsula of India, does not extend to the higher latitude of the Punjab. A few falls, some more heavy than others, some of longer duration than others, some occurring more frequently at one period of the year than at another, constitute all the rains that are received at Mooltan. During the prevalence of intense heat, not a drop of rain descends to relieve

the thirst of the parched soil. At the decline of the summer, a few heavy showers are obtained; and in the cold weather and in the frontier season intervening between the cold and hot weather, a few sparse falls occasionally occur at long intervals.

24. The fall of dew is very trifling throughout the year. The uniform temperature of the calendar day, during the continuance of the hot season, is a bar to the condensation of the aqueous vapour suspended in the atmosphere, and to its deposit at night in the form of dew. For half the year no appreciable amount of dew falls at Mooltan. It is hence that lesser vegetation has no source of moisture whatever, except what is provided by artificial means. Grass cannot thrive spontaneously in such a climate. The freedom of the night from dew-fall in the depth of the hot season is not without its advantage to man, oppressed as he is with the excessive temperature prevalent, for he can with safety enjoy a refreshing sleep in the open air, fanned by the cool breezes of the night. In the decline of the hot season, when the uniformity between the diurnal and nocturnal temperature does not continue, dew is observed to fall, but the quantity is not considerable, for the amount of evaporation during the day, though absolutely large, is but a little in excess of the amount that the atmosphere can retain at a reduced temperature. Not even during the cold months is the fall above a moderate amount, as the diminution of the absorptive capacity of the atmosphere keeps pace with the decline of warmth.

25. The winds at Mooltan blow mainly from a south-westerly direction. In the hot season, there are constant light breezes, proceeding irregularly from various directions, which are probably owing to the slight variations of atmosphere, due to the agency of the river and of the canals that intersect the District. These sometimes blow steadily from one quarter, and somewhat alleviate the distressing heat, and slightly mitigate the discomfort of a sultry atmosphere. In the depth of the summer, when the heat attains its acme, the wind acquires considerable force, and raises clouds of dust from areas of miles. Such gales are of frequent occurrence, sometimes as often as thrice in a week; and are remarkable for their effect of cooling the temperature of the atmosphere. The hot winds are of short duration, and blow steadily from the south-west.

26. Periodical inundations occur in the district round about the Station. These are perhaps due less to the rains that occur in the plains than to the heavy and long continued showers that fall on the lower ranges of the Himalayas, and to the melting of the snows on the higher and more distant mountains, from which the great rivers spring. The district about Mooltan is peculiarly liable to these inundations, from the number of canals which intersect it; and scarcely a year passes without floodings more or less extensive. These overflows occur at the period of the rains on the hills in the months of July and August, and the water does not disappear until after the latter month.

27. The above is a bare and meagre sketch of the natural features of the Station of Mooltan. The writer regrets that he had not the means or opportunity of recording more comprehensive and precise datas on these points. The account is founded on observation of such peculiarities of climate and soil as are cognisant to the senses, and does not take into consideration those subtle and powerful natural influences whose existence or force can be ascertained only by instrumental assistance.

28. The climate of Mooltan, as may be inferred from this description, has not many attractions, and it may fairly be represented as unsuited to the constitution of the European race. The intense heat, with its accompaniments of physical distress, dust-storms and hot winds, is far from agreeable to the sensations, or conducive to the maintenance of health of the European. The cold weather, or rather perhaps the middle of the cold weather, is the only period of the year in which the white inhabitant has the opportunity of preserving his health and of enjoying a passing season of physical comfort. The wide disparity in temperature prevailing at two periods divides the year into a season of distress and sickness, and a season of comparative enjoyment and of comparative health. This division admits of further partition, according as the existence of heat or coolness adds distress or imparts relief to sickness, and according as the prevalence of ill-health is diminished or aggravated by coolness or a high temperature. The onset of the hot weather is not marked by the production of disease, although much physical distress and discomfort

is experienced during it: but its decline is accompanied by a terrible increase of sickness, which is added to and intensified by the heat of the day. The onset of the cold weather, while it brings an alleviation to distressing sensations, is prolific of disease; while its middle and decline are enjoyable without drawback of either great warmth or of much sickness. The beginning of the year is the healthiest and most pleasant season. The mellow air, the clear sky, the bracing cold, combined with the previous enjoyment of a cool temperature for two or three months, during which the system has recovered from the relaxation and derangements produced by the prolonged heat, consummate a most agreeable condition of climate and physical health. When the advantage of a cool atmosphere is withdrawn at the onset of the hot weather, the system still possesses a stock of health and strength sufficient to defend it from disease for several months of the summer. With the further continuance of the heat comes a third season noted for sickness, which the high temperature increases and aggravates. On the departure of the summer and the advance of the cold season, there is a fourth period of alleviated physical distress, but of no cessation to the footsteps of disease, which tramp with increased cruelty on a system relaxed and weakened by the severities suffered during the prolonged summer.

29. From reflection on the points noted in this sketch, a fair approximative conjecture may be made regarding the set of diseases that are likely to be produced by the conditions of climate at the Station. Experience in all parts of the world indicates that the direct influence of heat on the European race, as well as its indirect power of producing other noxious agencies, is favorable to the lighting up of several diseases. The heat of Mooltan may be looked upon as the grand cause of the diseases prevalent in the Station. Its injurious influence, however, is less owing to itself, *per se*, than to its rapid alternation with cold. For a large part of the hot weather, when the system has to contend with, perhaps, the influence of intense heat alone, a very fair condition of health, in contradistinction to positive disease, is attainable. But when, as in the close of the hot weather, in addition to a high temperature, the system is assailed by an alternation to cold, the maintenance of a state of health becomes a concern of difficulty.

The great increase of disease observed to occur during the frontier season at the decline of the year, when the summer is subsiding into the cold weather, in a special manner points the observation to the transitions of temperature that are experienced at that time. Not only is there a decline from the high temperature that had prevailed for a prolonged previous period, but there is a minor decline experienced daily, according as the sun is above or below the horizon. These changes in the yearly and daily temperature without doubt produce functional derangements, which are due to the influence, on the great organs of the body, of heat and cold, following close upon each other. Ordinary experience makes us aware that a high temperature is powerfully stimulating to the skin. The visible, as well as the insensible perspiration is intensely and disagreeably increased, when the atmospheric temperature rises above a certain decree. A high temperature appears also to exercise a stimulating effect upon the liver. Its influence on the circulatory system is also exhilarating, increasing the rapidity of the heart's action, and causing more rapid transfusion of blood to all organs, adding thereby to the stimulus already operating upon them in a direct manner. Its action on the brain and nerves is also excitant. The stomach and bowels are likewise in a minor degree worked into greater activity, but the direct action of temperature on them is less marked than the vicarious influence exercised by other organs. In the case of other organs, whose functions are cognisable, as the lungs and kidneys, the influence of heat is counterbalanced by the greater activity of other organs. Thus the force of heat is more or less generally stimulating to all the great functions of the organism. The excitement does not imply disease, but rather theoretically a state of increased vitality. Increased secretion and assimilation are balanced by increased destruction and elimination. The functions, absolutely more active, can still maintain relatively to each other a condition of harmonious co-operation. A state of perfect health is attainable under an equable and simultaneous briskness of the animal functions, so long as their concord is not disturbed by other agencies nearly as powerful as heat, or by the material effect of heat independent of its vital influence, or by the laws enforced by the Creator upon all living mechanisms.

31. The physiological effects of cold of a temperate degree is, on the other hand, opposed to stimulation. The organs most markedly excited by heat work gently, moderately, and without hurry under the benignant influence of a lower temperature; but heavier labour is imposed upon those organs of which the functions are least excited by heat. The co-ordination of the organic functions is still maintained as in the opposite state of excitation by heat, and, as in the latter condition, meets the requirements necessary to health.

32. So long, therefore, as the human organism is permanently subjected to the influence of heat or cold, the functions may be carried on, under either condition, with the integrity necessary to health. When the system has assumed the disposition naturally produced by the influence of heat, a change to a lower atmospheric temperature necessitates a re-arrangement of the functional relations of the great organs. The previous activity of certain functions must now abate to a more slow and gentle industry, while other organs which have worked with moderate activity must now toil with increased energy. The change necessarily occasions a temporary confusion until it is fully established; but the new adjustment of the relative activity of the organs, when completed, becomes absolutely compatible with the maintenance of health. It is evident that the more slow and gradual the transition, and the less wide the extremes of the change, the less prominent will be the accompanying disturbance.

33. At the decline of the hot weather and the setting in of the cold, the change incumbent on the functions to meet the new condition of season is attended with a certain amount of derangement of the system, of which, perhaps, fever and functional disorders are the manifestations. But, in addition to the decrease of heat, due to the renewal of the seasons, there is likewise a daily rise and fall of several degrees of temperature. The great functions are placed under the necessity of daily adopting themselves in conformity to the great atmospheric changes. Scarcely has the arrangement suited to a lower temperature been initiated, than a rise of several degrees produces an obligation to return to the previous disposition. These incessant and continuous veerings in the working of the great functions of the economy cannot, it may reasonably be presumed, be executed with that immediate precision, by which alone can be avoided the confusion of individual function and combined action which constitutes disease. The more intricate and important the function, the more difficult is it to change and veer about to suit the transitions of temperature, and the more liable it is to fall into disorder.

34. Whether this speculation be correct or not, it advances a plausible explanation of the causation of the diseases prevalent at the decline of the year, that affords a certain satisfaction to the mind. The theory, at all events, is of ancient date, and has been more restrictedly employed in the explanation of the disorder of the liver and bowels occurring in the tropics amongst Europeans. It admits, however, of extended application to a variety of other diseases common in climates which possess two well-marked seasons of warmth and cold. The operation of the transitions from cold to heat would appear to be less pernicious than the reverse of change from heat to cold. Certain it is, that the unhealthiness at the decline of the hot weather is much greater than that experienced at the decline of the cold weather.

35. Intermittent fever is, *par excellence*, the disease of the Station; but, though this deduction may be readily made from observation of the climate, it is less easy to pick out from the peculiarities of the climate or other conditions, and to explain precisely, the cause of its origin. On the obscure subject of the production of fever, it is good to speak with diffidence, not abjuring old and familiar notions, nor emphasizing new ideas. The established opinion, that intermittent fever is due to the existence of *miasma* or *malaria*, is not applicable to the explanation of the fever occurring at Mooltan. The overflows of water are extensive and periodical in the immediate neighbourhood of the Station, but there is a marked absence of vegetation generally in the district to complete the conditions considered requisite for the formation of *miasma*. Another view that has been promulgated, that rapid drying of the soil after an inundation is productive of fever, is exactly met by the conditions existing at Mooltan; for the wet soil of the district after an inundation very rapidly dries under the rays of a powerful sun. This existence of the fever with the period at which the inundations occur indicates some connection between them, though the mind is unable to ravel the mystery of the manner in which the

human organization is influenced by the drying of the soil. The increase of moisture in the atmosphere is the immediate consequence of the drying of the soil, but it is not possible that the humidity is the source of the disease, as it is never considerable, nor greater than it is at the cold season. Nor is there reason for attributing the cause to a material peculiarity in the soil, for the same description of soil exists in other parts of the Punjab, in which fever prevails to a less extent. There may possibly be some electric influence communicated to the atmosphere during the conversion of the moisture into vapour. Without laying much stress on the opinion, it is not unreasonable to attribute a partial share in the production of the fever to a physiological cause—to the influence of the great and frequent transitions of temperature, experienced at the fever season, which cause a certain amount of derangement in the individual and correlative action of the great organs.

36. The intense heat of the climate for a long period of the year, and the frequent changes in temperature at the decline of the summer, have a most injurious effect on the functions of the liver. The stimulating influence of great warmth in many constitutions, especially when combined with imprudences in diet and drink, proceeds to the extent of the exhaustion of the powers of the liver, and even to the destruction of its tissue—a consequence that is accelerated by the inconstancy of the temperature following the relaxing and debilitating season of heat. The power of resisting the injurious effects of high warmth is exactly in the ratio of the original strength of the constitution—a weakly subject being more liable naturally to a break-down than a strong and healthy individual. The rapid performance of its function, and the increase of its share of labour in the physiological economy, contain in themselves the means of increasing the power and vigour of the liver, in accordance with the same law of nature by which a muscle thrives when in constant and energetic use. When the constitution possesses originally the requisite strength to meet the increased demand on its powers disease is kept at bay. Derangements of the bowels are no doubt, in some measure, owing to the direct action of increased warmth on their secretions, but by far the greater share in their production is probably due to the vicarious influence of other organs, and mainly of the liver.

37. The severe heat has also an injurious effect on the brain and nervous system. Its direct influence is noticed in the causation of sun-strokes, and in the tendency to cerebral affection in the fevers occurring in the hot weather. Its stimulating action on the nervous system leads to the acceleration of all vital operations, and disorder occurring in the latter is probably owing to exhaustion of nervous influence from stimulation beyond the power of the system to sustain. It is not an improbable view that the fevers occurring in the hot weather are the consequence of nervous exhaustion from heat, and not due to the entrance of any morbific agent into the blood. The sensations of languor and great lassitude, of inaptitude for either physical or mental labour, and the strong inclination to sleep, to all which sleep, when indulged in, brings no relief, are perhaps attributable to an exhaustion of innervation, consequent on the strong stimulating power of heat on a weakly system. Such sensations are as near an approach to the sensations experienced before an attack of fever, as described by authors, as can be conceived short of the actual disease. The condition known as fever may probably be an aggravation of this minor degree of enervation, due to the continued operation of the stimulus of high temperature, beyond the strength of a weakly or foreign constitution to endure long without exhaustion. In the season in which the atmospheric transitions are considerable and frequent, the nervous system is subjected to the alternation of high stimulation, with the withdrawal of stimulation, the effect of which is even more pernicious than the action of intense but even warmth, and more likely to produce the condition of nervous exhaustion, of which fever is possibly the evidence.

38. The skin, though very sensitive to changes of temperature, does not appear to be so liable to disease as other organs. The disease by which alone it seems to be attacked is ulceration of an indolent character, in the production of which a certain degree of exhaustion or of debility of the general integument may probably have a partial share. A minor change, not amounting to disease, is also noticeable. The skin loses its clearness and elasticity, and assumes a darker complexion—the latter change being probably owing to the special stimulation of the pigmentary secretion exercised by the bright light of the day.

39. From reflection on the climate as described in this sketch, one would hesitate to admit that the most dreadful disease known in India, cholera, is rare, or almost unknown at Mooltan. But such is the fact. With an exceedingly elevated temperature for half the year, and a fickle and inconstant temperature for a quarter of the year, with a climate favourable to disorder of most of the great functions, and in which disease rages with an intensity not observed in many stations where cholera prevails, this terrific malady is of rare and unusual occurrence. The inevitable inference to be drawn from such a fact is that cholera is not climatic; that it is not due to such peculiarities of climate which the Almighty has been pleased to ordain, and to their influence on the human organization. That its cause is derived from some transgression of natural laws, which man unwillingly or negligently commits, is irresistible. But from what peculiar error, or combination of errors, its origin springs is still beyond our perfect comprehension.

40. One great cause of this remarkable immunity from Cholera is, probably, the geographical position of the Station, and the commercial decay of the City. Situated as it is at a great distance from other large cities, in the centre of an extensive district, in which the communications are imperfect, and not possessing an active trade, Mooltan holds an isolated position, and is in great measure free from the danger of the seeds of the disease being introduced from without. There are likewise no shrines of considerable sanctity, and the risks of contagion from the visits of large bodies of pilgrims are not incurred. The theory of contagion with respect to the spread of cholera has lately been gaining ground, and there are certainly many reasons for entertaining that view. The condition of Mooltan in connection with its small liability to the risk of contagion from the ingress of masses of men likely to convey and communicate the disease, is an additional support to the growing doctrine.

41. While the comparative rarity of cholera withdraws from the climate any imputation of direct complicity with the causation of the disease, it likewise exonerates the artificial arrangements of the Station from the charge of supplying the conditions favourable to its development.

42. Having thus briefly recounted the climatic peculiarities of Mooltan, and the diseases that are probably lit up by their influence, it remains to consider the arrangements that have been adopted to meet these peculiarities, and to preserve, as far as possible, the health of the European troops.

43. In this consideration the habitations of the troops demand attention first. For in them most time is passed, and from faults in their construction or occupation the greatest hurt is received. The barracks in Mooltan are of superior character, compared with others in the Punjab. They are arranged *en echelon* in two lines, and accommodate each a hundred men or a company of Soldiers. Of great size and breadth, but little cubic space is withdrawn from their internal capacity by the central iron supports which have been substituted for the usual massive masonry pillars. The height is also very considerable, and the roofs are gabled, and consist of a light iron frame work, covered with matting and clay plaster. Their ventilation is effected by numerous doors and small attics, and by several perforated zinc plates placed at the angle of the gabled roof. They cover an extensive area of several acres, and appear to be as superior buildings for the accommodation of soldiers as any that have been erected in the Punjab.

44. The great advantage which they possess in the large measure of superficial space that they contain, so that the occupants get the amount of cubic accommodation granted by Regulation provided both in superficial space as well as in elevation of the roof. The great defect in their construction, a defect, however, less marked in them than in other barracks, is that the ventilation has been adapted with stronger reference to the warm than the cold season. When the warmth of the weather admits of the doors and windows being thrown open, the ventilation is as perfect as could be desired, for it is but a slight remove from the ventilation of an open plain. In the cold season, when a strong current of cold air is neither beneficial nor agreeable, and in the depth of the hot season, when it is a relief to shut out the heat and light, the ventilation is confined and almost cancelled by the necessary closing of the doors. This observation, for obvious reasons, should be considered most strongly in reference to the nocturnal ventilation of the buildings during the cold months. In all questions of ventilation in a variable tropical climate, the provision for nocturnal ventilation in the cold season should be the

leading object, for that efficiently arranged will include the means of ventilation by day or night in all seasons.

45. Ventilation by means of doors and windows is so easy and readily provided, and when provided makes such a specious appearance of thoroughness and abundance, that it would appear to have thrown out of consideration the question of how ventilation is to be effected when it becomes necessary to close doors and windows. The necessity for shutting up a house or barrack occurs in two seasons in the Punjab. It is quite as necessary to do so during the day in the hot weather to exclude the heat and intense light as it is during the night in the cold season to keep out the cold. The need of means for providing efficient ventilation on these occasions does not appear to have been considered. The provision of additional and supplemental contrivances for ventilation is less urgent in private dwellings, in which the inhabitants do not number more than a few individuals. But in barracks occupied by a multitude, it is an absolute essential for the preservation of health.

The dry room at the Quarter Guard of the European Regiment is probably the nearest approach to the Black Hole of Calcutta existing in the nineteenth century. For, perhaps, a trifling military offence, an unfortunate soldier is incarcerated for many hours or a whole night, with perhaps several others, in the hottest season of the year, in a small, narrow, and badly ventilated room, scarcely sufficient for the confinement of two or three individuals. The prisoners convicted of the gravest offences, confined in a Punjab Jail, under the present administration, have perhaps superior accommodation. The cells are better, but are far too close. Indeed, it would be well if the Engineers of the army could be prevailed upon to take a lesson in the construction of cells for soldiers from the convict jails in the Punjab.

46. The offices of the barracks are detached. The wash-houses are at some little distance from the barracks, so that access to them is not practicable without exposure to the sun. The separation of the cooking houses and privies is more excusable. The privies are managed on what has been called the "dry system," owing to the scarcity of the water supply. The cleansing of the privies, and the removal of the filth in carts, are admirably effected so much so that the

late Sanitary Commissioner of the Punjab—whose special *forte* for the detection of nuisances is well known and appreciated,—reported well on the military privies at Mooltan, and particularly noted their superior management. The eulogium is less applicable to the offices themselves as buildings, than to their freedom from offensive smell. For this quality they are probably indebted to their proximity to the barracks necessitating constant and rigid attention to their condition.

47. An excellent institution for providing the means of personal cleanliness is appended to the barracks. A swimming bath, well provided with clear water, frequently changed, has been erected at each end of the block of barracks for the European Infantry Regiment. Not only do these means for washing exist, but they are used by many men voluntarily, and a regimental usage, sternly enforced by an energetic Commanding Officer, effectually provides a periodic bath to every man in the regiment.

48. The hospital for the European Regiment, when completed, will be perhaps amongst the best military hospitals in the Punjab. As it is, however, but one wing of the complete building that is eventually to be erected, the accommodation it affords at present is insufficient for the sick of an Infantry Regiment in a station like Mooltan. As a habitation it is virtually inferior in sanitary qualities to the barracks; for, in the most unhealthy season of the year, its occupants are far more numerous than the number in the individual company barracks, and the cubic space then obtained by each sick soldier is less than the cubic space that he obtained while residing, free from illness, in the barrack. The cubic capacity of the building is likewise greatly lessened by the partial partitions and the masonry pillars that have been erected in the interior for the separation of the central and lateral apartments and for the support of the roof, as the light iron pillars employed in the barracks have not been introduced into the construction of the hospital. The ventilation has also been arranged on the same principles as that of the barracks, and thus while the ventilation is perfect in a season during which the doors can be kept open, it is most injuriously insufficient on occasions when the doors are of necessity closed.

49. In the depth of the hot season, it is a matter of sheer necessity to exclude the heat and light of the day by closing

the doors, which form almost the only means of ventilation provided for the hospital; and the same necessity arises during the nights of the cold season to keep out the cold. To meet these occasions, which are by no means exceptioned, but extend over periods of several months, there are no contrivances for admitting currents of fresh air. A mitigation to a partial extent of the necessity for closing the doors is afforded by the use of thick chicks and purdahs hung in the verandahs all around the building. But these, it is obvious, impede the existing ventilation in the same proportion in which they exclude the heat. A visit to the hospital on a hot day or a cold night, before the doors have been opened and the ventilation restored, will afford convincing proof of the urgent and absolute necessity for the provision of additional means of ventilation, and the falsity of the exclusive reliance on doors for effecting ventilation at all seasons of the year.

50. A great error in the construction of this hospital, which it shares, however, in common with every hospital in India which the writer has seen, is the absence of suitable conveniences for the sick. The want of closets or private retreats, distributed through the different wards, for the use of the debilitated, in addition to the common privy provided for the able sick, is a crying evil. In many forms of sickness, the patient is far too weak to proceed to a distance of thirty or forty yards to relieve himself; and instances have occurred where men have endured great distress, and have even fainted, in their endeavours to reach the distant privy. There are also occasions when it is necessary for the proper investigation of disease and for the conduct of treatment that the evacuations should be preserved for the inspection of the practitioner. Under these circumstances, the usage is to provide for such cases a close stool, which is placed on the verandah, so that when a large number of debilitated sick is in hospital, the verandahs are ornamented with a score of pans, reeking with offensive contents. Thus the purposes for which the verandahs are intended, as covered promenades and sitting places for the sick, and as reservoirs of cool and sweet air from which the interior room may be supplied, are entirely perverted.

51. One huge and continuous apartment, even when partially partitioned to constitute a hospital, is not calculated to provide that privacy, separation, and quiet which is necessary

to the comfort and well-being of the sick. The individual oppressed with fever and on the verge of delirium, the patient sinking slowly from organic disease, with his mind conscious of his sure descent into the grave, are not fit chums to mate with the subjects of minor disease, whose spirits and actions are in no ways influenced by severe pain, or physical exhaustion. Even in health, men feel restive and impatient when herded hourly and momently with other men, whose behaviour, even when not indecorous, is not compatible with their humour of the moment. The intermixture of men suffering from severe forms of disease with a multitude of others less afflicted deprives them of the quiet seclusion and freedom from annoyance which their condition requires. The want of seclusion and snugness is the great drawback to a hospital consisting of one huge apartment.

52. No comprehensive measure for the preservation of health and physical vigour amongst Europeans in this country will be complete until means are invented for reducing the temperature of apartments, as practical and convenient as the means applied in cold countries for producing warmth. The existing contrivances are unwieldy, cumbrous, and but partially applicable to the cooling of large apartments. The expense of employing them further barely compensates for the little relief which they afford. The experience of the British in India for the past century is sufficient to indicate that the established contrivances are ineffectual, and that more perfect and thorough means of reducing the temperature of dwellings should be sought for in other directions. Much ingenuity, talent and reflection would appear to have been devoted to effect the improvement of the prevailing method, but ingenuity and talent have been employed in vain. It is perhaps now time to abandon further efforts on such barren ground, and to turn research towards other fields. The minds of ingenious men, diverted in other directions, may discover some new method more simple and efficient for the purpose.

53. Any change in the means employed in cooling apartments will probably require a change in the prevailing method of ventilating barracks, perhaps also a change in the established style of architecture. The innumerable doors will probably no longer be needed, and perhaps be an impediment to the thorough cooling of apartments. Even with the contri-

vances in use, several adaptations may be applied to buildings to render their interior cooler than the open atmosphere in the hot weather. The covered area around buildings, called the verandah, may be widened with advantage. A verandah of double or treple the width usually given will secure the double benefit of greater coolness and greater shade; while the hindrance to the admission of breezes in hot weather and to free ventilation may be avoided by greater elevation in the roof. It is thus that houses are kept cool in the Confederate States of America, in which the climate is described to be as warm as in India, so much so that the out-door manual labour of whites is not practicable. The exclusion of the intense light of the sun is desirable, and any method for reducing the temperature of buildings would be enhanced in value if it comprehended the shading of the light. Independent of the relief afforded to the eyes by the partial darkening of apartments, a very probable advantage arising from it would be the preservation of the complexion and personal appearance of Europeans, though to this end thorough ventilation has far greater influence.

54. Another contrivance for the exclusion of heat which may be found practicable is the thickening of the walls and roofs. In many remains of buildings erected in the time of the Mogul domination, the walls and more especially the roofs are of great massiveness, and they would appear to have been so made as much for protection from the solar heat as for durability. Double walls and double roofs may also be supposed to be efficacious in shutting out the heat, while they may likewise be employed in effecting excellent ventilation. The principle has already been appropriated by an inventor in the construction of the felt helmet. A hollow cylinder is said not to be deficient in strength, and probably hollow walls may not be found to partake of weakness.

55. Storied buildings do not appear to be popular in the Punjab, but there does not seem to be a reasonable sanitary objection to employing them. On the contrary there is a strong probability of storied buildings being cooler than single ones, both in the lower and upper apartments.

56. The many defects of buildings, both public and private, indicate a sad want of architectural talent in the country. The idea of a barrack entertained by the Indian architect is a huge masonry box, perforated by an indefinite number of doors and windows. The means devised to provide this ideal are as simple and primitive as the object. The wide and bare ideal is presented, without investiture with the additions which ingenuity and fancy suggest, and which the physical and artificial wants of men absolutely require. When additions exist, they have been provided with an unskilled and awkward hand. No prominent advance has been made on the primitive ideal. The progress in barrack building would appear to have comprised mainly improvement in the handicraft arts, enlargement of the building in height and width, and the better disposition of the individual buildings. Without depreciating the value and importance of progress in these particulars, barrack architecture is still in a rude state, not in character with the advance of the age, nor with the genius of the dominant nation. The difficulties arising from climate, the want of skilled labour, and from other causes, are no doubt considerable, but they are not overwhelming, and much greater progress might have been attained in spite of them if the special talent necessary to meet them had received proper encouragement.

57. The call for accommodation for soldiers has been of late years very great, in consequence of the increase of the European force maintained in India since the mutiny. Very considerable sums have been expended in the erection of new barracks and in the extension of old barracks. The multiplication of the military hospitals and other buildings has been in proportion. It had lately been perceived expedient to indent upon the mother country for special ability and knowledge to supplement the versatile talent of the governmental services, in great and important duties. It is to be regretted that the same expediency was not perceived when the necessity arose for increasing to an enormous extent the military buildings in the country. The large outlay, the importance and the extent of the work to be accomplished, would have justified the employment of an eminent architect to devise designs and to elaborate improvements. The introduction of a new mind, replete with the knowledge of the age, and ignorant of antiquated precedents, would have done much to improve the prevailing system with fresh and vigorous conceptions, and to remedy the many deficiencies and faults which are now perpetuated from the absence of architectural ingenuity to correct them.

58. The rations of the troops at Mooltan are not good. It is to be regretted that at such a Station greater efforts are not made to provide this grand essential to health. The meat, both beef and mutton, is very inferior, being lean, insipid, and with the fat, which is singularly disproportionate to the lean, of a deep yellow colour. It was well when these were the only faults. The contractor being under engagement to supply merely grass-fed cattle, the quality of the meat cannot possibly be good in a district in which pasture is difficult to procure. The bread is likewise of inferior quality. Whatever may be the cause, whether adulteration with the flour of other grains, or whether an inferior description of wheat is obtained in the district, the bread is neither in taste nor appearance equal to the bread obtained elsewhere. Frequent faults were an unpleasant grittiness and acidity, the latter steadily increasing the longer the bread was kept. The bakers in this country do not appear to be unanimous in the employment of any one substance for the purpose of raising the dough. The particular substance employed by any one baker is kept concealed as a trade secret, and no consideration will induce him to divulge it. In the absence of precise knowledge regarding the substance, or combination of substances employed, it cannot be said whether it is in any way injurious. The acidity of the bread is probably, however, due to this substance, either to its staleness, to its improper combination, or to the disproportion of any one ingredient in the mixture. It is impolitic and unwise that any secret substance should be permitted to be employed in the preparation of food, and it is against the general usage of the army. The employment of secret ferments is, however, to be discontinued shortly, as Government has decided on the issue of yeast for the manufacture of bread for the troops. The supply of this best of all ferments is easily procurable in Upper India from the large breweries that have been established in the Stations on the hills.

59. Vegetables are not procurable at Mooltan throughout the year. Carrots, turnips, cauliflowers, cabbages, beet-root, and many other vegetables are procurable for many months, but the supply is not persistent throughout the year. By far the most important vegetable, the potatoe, is not cultivated in the district, as far as the writer's knowledge goes, but is obtained from Lahore. The supply of the potatoe to the

troops is intermitted by the Commissariat for several months during the hot weather, in consequence of the enormous expense of carriage and the enhanced market price at this season. The potatoe grows in the Punjab and on the hills, and is obtainable throughout the year, but there are very great variations in the price, and cost of carriage. It is worthy of reflection whether these reasons are sufficient for cutting off the supply of a staple from the usual diet of so valuable a class of men as are European soldiers in India. Independent altogether of considerations of moral equity, but with reference solely to the pecuniary bearings of the withdrawal of the supply in consequence of greater cost, the economy of the proceeding is less obvious than its improvidence. The outbreak of scurvy that occurred amongst the men of the 101st Regiment in 1862 was in all probability due mainly to the withdrawal of this important article of diet. It was difficult to provide a proper substitute in such a wild district, and onions and dhall, which were issued in lieu, but indifferently supplied the place of the potatoe. From the known character of the disease when it appears amongst large bodies of men, it may be inferred to what extent scurvy prevailed in that Regiment, and the amount of suffering, loss of efficiency and death that was presumably attributable to that disease. When the money value of the life of a European soldier in India, the cost of the means of relieving illness, the long continued expenditure incurred in consequence of it, the loss of the services of sick and weakly men, and the inconvenience to the State arising from the physical inefficiency of a Regiment, are balanced against the enhanced cost of the supply of an important article of food, the difference will probably indicate the expediency of incurring the immediate expenditure to avoid a prospective and greater outlay. Such views are, without doubt, of great influence with the Government, when judiciously represented by high officials on occasions of difficulty. There is perhaps no well-settled Government in the world where financial interests are so bound up with the duties and claims of the army, and whose conduct towards the army is so liberal and considerate, as the Government of India. The disasters consequent on the withdrawal of an article of food were probably not foreseen, or, if foreseen, were not well considered. An energetic alacrity was, however, displayed when the outbreak manifested itself unmistakeably.

Probably a much larger immediate expenditure was then incurred than would perhaps have been requisite had arrangements for obtaining a regular and constant supply been made earlier in the year. The completion of the Railway from Mooltan to Lahore will shortly furnish the means of obtaining food at a cheaper cost, and of thereby increasing the sanitary opportunities of the garrison of the Station.*

* The following is an endeavour to contrast the probable cost of the supply of potatoes to one Regiment at Mooltan during the hot weather with the probable cost of the contingencies liable to occur on a outbreak of scurvy, which disease may be fairly attributed in the main to the withdrawal of so important a vegetable from the ordinary food. There being no precise data to proceed upon, the amounts named are consequently conjectural. They are not believed to be exaggerated, but rather under-estimated. The inconvenience to the State from the reduction of strength of a Regiment which has been stationed at Mooltan and which has suffered from scurvy, may be inferred from the tact that an old and distinguished Regiment, the 101st, which numbered nearly 1,200 men in its ranks in the middle of 1862 at Mooltan, was only able to take about 500 effective bayonets into the Field during the frontier campaign in October 1863. Other causes, of course, also had an influence in their weakening this Regiment.

	Rs.
Value of potatoes for an average of 1,000 men, for 6 months, at 1lb. *per* man *per diem*, at Rs. 12 per maund, For 2,250 maunds ...	27,000
Deduct value at ordinary rate, at Rs. 4 per maund ..	9,000
Increased expenditure ...	18,000

	Rs.
1. Value of lives lost directly or indirectly from scurvy, at 0·75 per cent., about 8 ...	8,000
2. Cost of 8 substitutes ...	8,000
3. Cost of medicines for treating scurvy, and diseases aggravated by scurvy for 1 *per cent.*, for 6 months, at Rs. 5 *per* sick man *per mensem*	300
4. Cost of wine, beer, and extra articles of diet for above, at 12 annas per man, calculated on a daily average of 10 men	1,350
5. Loss of services of 1 *per cent. per diem*, at 4 annas *per* man, for 6 months	450
6. Expence of sick furlough to Europe and invaliding of 1 *per cent.*, return to India, land transport, and loss of services, &c.	5,000

60. The beverages supplied to the troops are for the most part excellent. The beer brewed on the hills has not yet been carried down so far south as Mooltan; but the supply of English ale is steady and of very superior quality, due to the facility of communication existing with Kurrachee by means of the steam vessels of the Indus Flotilla. The price at which this excellent beverage is sold at the regimental canteens brings it within the means of the private soldier. Porter is likewise issued, and is of equal excellence and cheapness. The rum supplied to the soldiers is manufactured in the country, and is also of good quality. If any objection to it exists, it is that it is somewhat diluted, but the strict supervision exercised over the canteen arrangements by regi-

	Rs.	
7. Prospective expenditure on account of debilitated men, and loss from early invaliding		5,000
8. Cost of lime juice for 200 men a day for 3 months		1,000
9. Expenditure on account of women and their children similarly affected, or sent to England with their husbands, &c. ...		3,000
		32,100
Deduct hospital charges recovered from men, *vide* No. 3, at 2 annas *per diem* ...	225	
Reduction of expenditure in the pay of women and children, from deaths, and removal to England ...	150	
		375
		31,725

According to this conjectural estimate, when potatoes are not issued, the loss amounts to Rs. 22,725. But as onions or dhall, or some other article is usually substituted in lieu of potatoes, the loss may be estimated at Rs. 25,000. An increased expenditure of Rs. 18,000 would prevent the ultimate loss of Rs. 25,000.

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mental authorities has banished the employment of deleterious adulterations. A certain recognition is given to the sale of ginger beer and lemonade, prepared in the regimental bazars, to the troops. These beverages, on the whole, are of fair quality, and tolerably palatable. The constant examination made into the stores of the venders, and their liability to fine and expulsion from the bazars, ensure the employment of proper ingredients.

61. Recognition is not given to the sale of spirituous or malt liquors to the troops out of the regimental canteens; and a prohibitory clause is introduced into the licenses of dealers established in Cantonments. The objects of the prohibition are to decrease the facilities of indulgence by the soldiery, and to prevent their access to adulterated liquors. The operation of the prohibition has not, however, attained these objects. While respectable dealers are effectively deterred from supplying the soldiery, the sale of highly deleterious spirituous mixtures at high prices is clandestinely carried on by enterprising natives. The efforts of regimental and magisterial authorities have been ineffectual in suppressing this secret trade. That it exists is unquestionable (though not to a large extent at Mooltan). "The almighty rupee," it is said, will enable the soldier, who is so disposed, to obtain the means of intoxication in any part of India, and under any circumstances, in spite of the most stringent legislative prohibitions.

62. The canteen system has been the means of effecting much good, and of bettering the general morality and health of the soldiers. The benevolence of the Indian Government, which is not the less admirable because it is in a measure interested, has provided the army with an excellent beverage, of superior quality, which it retails at a price which places it within the reach of the private soldier. It is well, however, to consider whether the limitation to the sale of liquors to individuals at the canteen, and the restrictions with reference to the soldier imposed upon general dealers, effect more good than would be derived from the withdrawal of the restrictions. The absolute prevention of excessive indulgence by some men is perhaps virtually impossible. No amount of prohibitory measures can restrain the individual who has the craving for a drink from obtaining access to some means of intoxication. The present system signally fails in reclaiming such

men. Individuals of this stamp, whose number fortunately is not great, may with reason be excluded from consideration. It would be well if they can be summarily dismissed from the army, for they are wanting in a radical element of the military character, the element of being "ever ready." It is with reference to the great body of the soldiery that the question should be regarded. The limitations of the hours, duration and amount of the sale, the impossibilities of the soldier's obtaining good liquor but at one hour and at one particular place, should be considered in its relations to the secret sale of adulterated and high priced intoxicating mixtures, to the demand that may be created for these, and to the tendency to exceed which clandestine indulgence is apt to generate amongst good men who would not be immoderate, if allowed full liberty under wholesome regimental influences.

63. What has been achieved in the provision of good and wholesome beverages remains to be accomplished in the supply of food. The present arrangements fail in particular instances to secure to the soldiery a supply of good and nutritious food. The causes of the failure are less due to the system than to the deficiencies of the country. The cattle are degenerate and inferior; in Mooltan remarkably wretched. There appears to be an indifference to the proper care and rearing of stock; and little attention is paid to the food of cattle. The existing system has perhaps never failed in providing the army, whether in the field or in garrison, with a supply of food; but the food has not always been of good quality. It is time to endeavour to improve the quality of food, both vegetable and animal, to be obtained in the country. Speculation appears to run too much in limited circles. European capitalists do not seem to be alive to the openings of wealth offered by the ordinary wants of the immense army in India. The gigantic fortunes amassed by Commissariat contractors are broad evidences that the supply of food to the army is a most profitable enterprise. European conscientiousness, knowledge and management are wanted for the improvement of produce. It would be well if the Government would lead the way in this as it has already done, with great success, in other important undertakings.

64. The clothing of the troops is excellent, and suited to the great disparity existing at Mooltan in the temperature of

the seasons. There is one description of clothing worn during the summer, and another during the cold weather, and both are admirable in their texture and elegance, and in their perfect adaptation to the climate. It is to be regretted that any addition to the ordinary clothing worn by the troops is considered necessary for the army in this country. What is called the full-dress tunic is virtually a superfluity. It is not suited to the comparatively moderate climate of the cold season, and it is a very objectionable habiliment for the hot weather. The serge tunic has almost superseded the full-dress tunic, and is worn on all occasions but those of extraordinary ceremony. As it combines comfort, moderate warmth, and much elegance, it may ultimately effect the desuetude of almost the last relict of the antiquated English costume. The old fashioned lappets, lace and gilt buttons on the sleeves, the stiff collar, and the tawdry profusion of tarnished lace worn by the Officers will not, perhaps, much longer compete with the simple elegance and the perfect comfort of the loose tunic. The summer tunic differs from the serge tunic only in colour and texture. It is deservedly very popular, and is perhaps the most handsome article of dress invented for the army. A young and well set Officer looks an Adonis in his simple white tunic and scarlet sash. The contrast of colours is pleasing to the eye. A regiment clothed in the mixed uniform of red and white colours, worn during the transitions of the seasons, is a very pleasant spectacle on the parade ground.

65. Most of the objectionable articles of dress of the British Army are not now worn in this country. Public opinion and improved common sense have relieved the soldier in India from the infliction of sumptuary miseries in the discharge of his duty. The gain has not been only on the side of the soldiery, but has also been shared by the State in the reduction of Military expenditure. The extinction of the full-dress tunic and of many superfluous fripperies of uniform would much reduce the cost, without affecting the efficiency of the army. It is of much more importance to the nation, and more conducive to the interests of the army, to strengthen the stamina and physical power, and to ameliorate the condition of the soldiery, than to impose the use of unnecessary and even objectionable articles of costume. The balance of lessened expenditure on uniform may well be restored to the army by

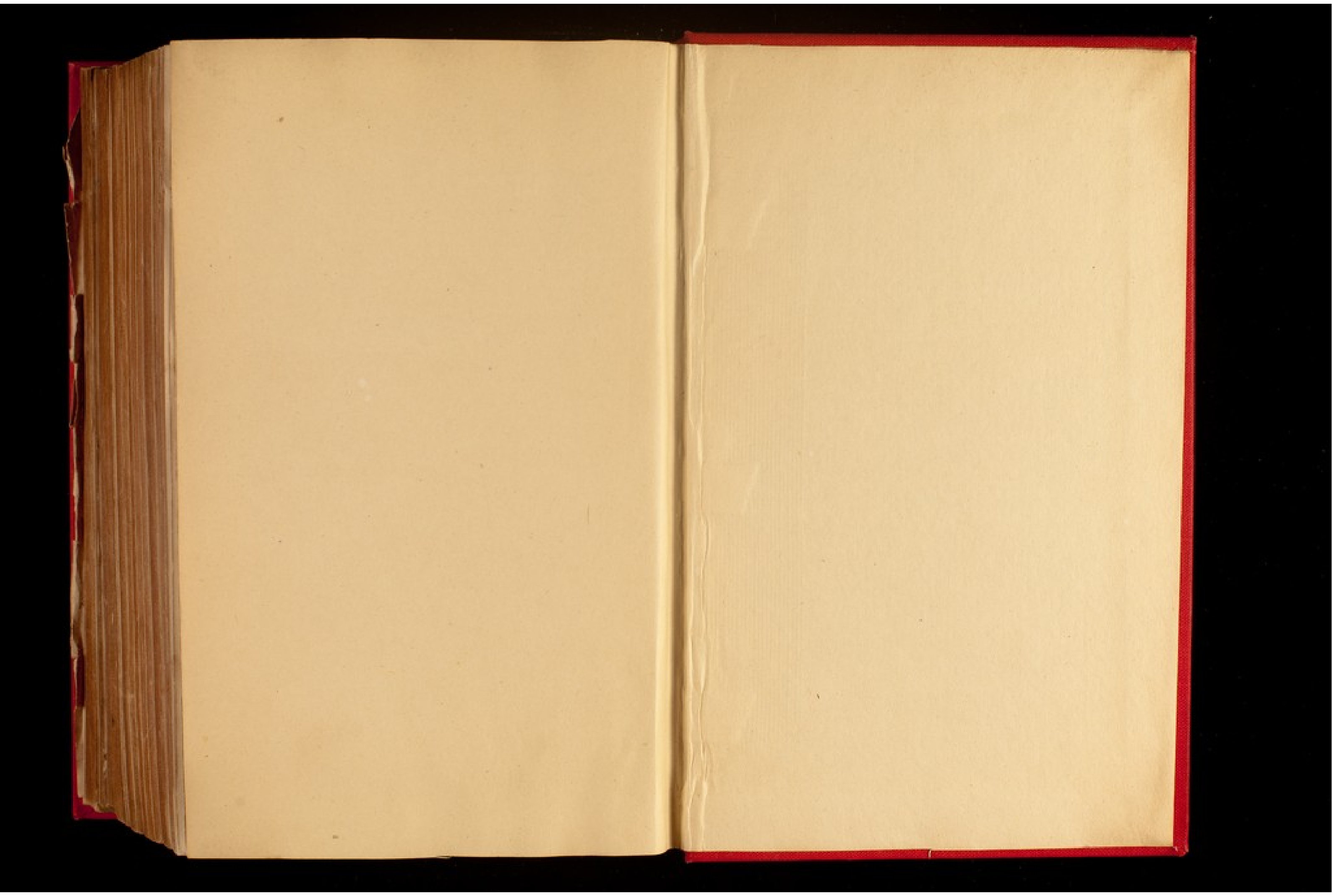
improvements in victualling and housing, by the extension of marriage, and by the carrying out of various projects for adding to the happiness and prolonging the life of the most important class of men in India to British interests.

66. The social life of the soldier plays no small part in the causation of the conditions that deteriorate his health and impair his efficiency. Less powerful than physical agencies in its direct operation, it contributes in a considerable degree to weaken the natural resistance to their influence and the natural tendency to recover from their effects. Its operation on the physical constitution is through the mental and moral susceptibilities of the soldier. The monotony and restraints of barrack life, the great absence of domestic and social amenities, the want of many of those calls and resources which vary the life and interest the feelings of ordinary men, have much influence in impairing the elasticity of the mind and constitution of the soldier in India. The ultimate influence of the social stagnation of the soldier is the depression of his vital force, of the natural conservative capabilities of his system, of the natural resilient and reparative tendency under disease. To this subtle influence is probably owing the extraordinary facility with which the soldier is attacked and overcome by disease, and the difficulty with which he recovers from its effects.

67. The social life of the soldier is thus by no means an unimportant element in his physical well-being. It is but lately, however, that attention has been directed to it. It is to be hoped that a more comprehensive consideration of the position of the soldier in India, and that a more enlarged sympathy and benevolence, will improve his present hapless social existence.

68. One constituent of the social life of the soldier is the amusements which he indulges in. At Mooltan, a building was in 1862 constructed specially for a theatre through the enterprise and public spirit of a young Officer of the 101st Regiment. In that year the performances, which were tolerably frequent, afforded to the men considerable amusement and matter to talk about. Cricket is now established as an institution in most, if not all regiments. Skittle alleys and racket and tennis courts exist at the Station for the use of the men. Occasionally a dancing party is got up by men, commissioned

officers, or the band. Once a year comes an event of great festivity and enjoyment, the station races. The kindness of Officers invariably provides on these occasions special amusements for the men, in the way of foot races, poney races, jumping and climbing matches, Aunt Sally, negro serenades, &c. It is to be regretted that the women and children of a regiment are not in general so much considered as they ought to be in all these efforts for amusement. Arrangements are made generally solely for the men, without reference to the participation of their wives or children. There are indications, however, of an improved and pleasing kindness being now extended to the families of soldiers by Commanding and Regimental Officers.



PAMPHLETS

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