TS

Buchanan	Sanitation in St Giles
Haughton	Urine
Böhm	Ventilation & Hospitals
Murray	Instinctive movements
Begbie	2d. heart sound
Lister	Coagulation of the Blood
Budd W.	Variola ovina
Begbie	Exophthalmos
Hassall	Oxalate in Urine
Acland	Cowley School
Naquet	Des Sucres (Saccharimetrie optique) p 74
L. Lindsay	Murray's Asylum
	Exam. of Recruits
Weber	Crura cerebri
Thury	Production of sexes
Haughton	Diabetes Mell.
Dornier	Boots & muscular power
Sankey	Paresis
T. Fox	Skin parasites
Gordon	Transport of Troops
Teevan	Fol. urinals
Curling	Sterility in man
Rasmussen	Kidney

Bush Craniometry
Gull. Propr. atrophy of hand

(40)

1862.

SANITARY STATISTICS

AND

PROCEEDINGS

IN

ST. GILES' DISTRICT.

BY

GEORGE BUCHANAN, M.D.,

Medical Officer of Health.

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ANNUAL REPORT

OF THE

Medical Officer of Health.

SECTION I.—On the Mortality of the Metropolis in 1862.

The year 1862 has been characterized by an unusually high mortality in London. Allowance being made for increase in population, the deaths were more numerous than in any year since 1858. Sixty-six thousand, nine hundred and fifty persons died in the year, giving a death rate of 23·41 in the thousand, or one in every forty-three inhabitants.

Among the diseases that produced the high mortality in London in 1862, an epidemic of typhus first requires mention. Although every year large numbers of deaths are registered from so called typhus fever, the real typhus which especially occurs in an epidemic form had been practically absent from London for several years, until in the latter half of 1861 it again appeared with its well known epidemic characters. In the course of 1862, 3742 deaths from various fevers were registered in London, the highest number in any of the preceding five years having been 1996. Of the 3742 deaths it is probable that upwards of 2000 were from true typhus.* But though the reappearance of typhus has thus swollen the mortality from fever, still, the zymotic class of diseases taken as a whole, shows only a slight excess of deaths in 1862. Scarlatina, measles and whooping-cough each contributed their full annual average of deaths—not much beyond it. Small-pox was quiescent, waiting for another accumulation of unvaccinated persons before renewing its epidemic visitation in 1863. Another great member of this class, diarrhœa, was markedly less fatal than usual, and its subsidence mainly has prevented the zymotic mortality from being very high in London.—The other causes of death that exhibit material fluctuations from one year to another, being much affected by the atmospheric conditions that prevail, are Consumption and Diseases of the lungs. From diseases of the former kind the number of deaths recorded in 1862 was very much the average of the last five years, while from diseases

* This disease usually causing about one death in every six persons that it attacks, it follows that the serious number of 12,000 persons have suffered from typhus fever in the year, almost the whole of whom belonged to the poorer classes of society. A special economic interest attaches to the prevalence of typhus. It is the epidemic disease which of all others carries off the heads of families. Most diseases of this sort find their victims chiefly in children.

of the lungs, the deaths were rather less numerous than common. The nature of the seasons in 1862, so far as they bear on the prevalent causes of death, may be summed up by saying that the temperature was more even, higher in the winter months, and lower in the summer months, than usual, and that there was throughout the year a larger rainfall than is common for the metropolis.

It was especially the Eastern and Central divisions of the metropolis that suffered from the high mortality of 1862. In the Central districts, which include St. Giles' at the one end and the City Unions at the other, the death-rate was most especially high, exceeding not only that of any recent year but even exceeding the average of the ten years that preceded 1857. Table I. of the Appendix will show the incidence of mortality on each group of districts.

The largest number of deaths occurred as usual during the first and last quarters of the year, the smallest number in the third quarter. This variation is mainly due to the unequal distribution of deaths from lung disease. But other disorders not so directly dependent on temperature, also exhibited notable fluctuations. Thus, measles and scarlatina were increasingly fatal through the year, so that in the fourth quarter these two disorders caused twice as many deaths as in the first quarter. Small-pox too was giving threats, before the year was out, of the epidemic character it was about to assume. On the other hand whooping-cough and typhus declined from the earlier to the later part of the year. Diarrhœa culminated of course in the hot season. The fourth of the tables appended to this report shows in detail the progress of each class of disease through the four quarters of the year.

SECTION II.—On the Aggregate Mortality of Saint Giles' in 1862. Comparison with other Districts.

The mortality of London and of the central districts being thus high, the death rate of St. Giles' was of course also in excess. In the year 1862, the large number of 1563 deaths occurred among residents in St. Giles' district. This number represents a rate of 28·9 per 1000 inhabitants, being a considerable increase above the death rate of any recent year.

Of the 1563 deaths, 1483 were registered within the boundaries of St. Giles' and Bloomsbury; and 80 occurred in the Hospitals of other districts (Appendix II.) There was, as usual, a large excess of deaths among males, 814 of them having died to 749 of the other sex. Fifty-four of the 80 Hospital deaths were among males.

The average age at death was 27 years and 10 months. Four hundred and seventy-six infants died before they were two years old, and 191 others between the age of two and five. Forty-three out of every hundred deaths therefore were those of children under 5 years old.

In the Table on the opposite page, a detailed comparison is given of the mortality of St. Giles', with that of the several districts that surround it. Correction has been duly made in each instance for deaths in Hospitals and outlying Workhouses. It will be seen that there is, as usual, a higher death rate in St. Giles' than in any of the neighbouring districts, and no less than 5½ per 1000 above the average of London. In 1862, however, as in the preceding year, Holborn had a mortality so exceptionally high, as to rank this district

MORTALITY IN 1862.

DISTRICTS.	Population, 1862.	REGISTERED MORTALITY. 1st Quarter, 13 Weeks. Actual number.	1st Quarter, per 10,000.*	2nd Quarter, 13 Weeks. Actual number.	2nd Quarter, per 10,000.	3rd Quarter, 13 Weeks. Actual number.	3rd Quarter, per 10,000.	4th Quarter, 13 Weeks. Actual number.	4th Quarter, per 10,000.	Whole Year, 52 Weeks. Actual number.	Whole Year, per 10,000.	Column A. (see Note.) (add)	Column B. (subtract.)	Total Mortality in 1862 corrected for Cols A. & B. Actual number.	Total, per 10,000.	DISTRICTS.
St. Pancras ...	202,011	1273	63·0	946	46·8	1093	54·1	1210	59·9	4522	223·9	126	Hospls. 152; Workh. Strand 144; 296	4352	215·5	St. Pancras.
St. Marylebone	162,000	1139	70·3	881	54·4	869	53·6	959	59·2	3848	237·5	140	Hospital, 147	3841	237·1	St. Marylebone.
METROPOLIS	2,859,778	18,405	64·3	15,695	54·9	15.133	52·9	17,717	61·9	66,950	234·1	—	—	66950	234·1	METROPOLIS.
Holborn	44,685	361	80·8	298	66·7	256	57·3	295	66·0	1210	270·8	95	Hospital, 69	1276	285·5	Holborn.
Strand	42,810	258	60·3	243	56·8	232	54·2	275	64·2	1008	235·5	Workh 144; Hosps. 45; 189	Hospital, 107	1090	254·6	Strand.
St. Martin's ...	22,436	162	72·2	126	56·2	141	62·8	141	62·8	570	254·0	31	Hospital, 67	534	238·0	St. Martin's.
St. Giles's	54,026	413	76·5	347	64·3	352	65·1	368	68·1	3480	274·0	80 Hosps. and 3†	—	1563	280·0	St. Giles's.

* Col. A. gives the number of the Inhabitants of each District who expired in 1862, in the Public Institutions of other Districts; these figures must be added to the Registered Mortality. Col. B. gives the number of Inhabitants of other Localities, who died in the same year in the Public Institutions of the Districts named; these figures have to be subtracted from the Registered Mortality. (*See Appendix Table II.*)

† This number 3 requires to be added as the balance of certain errors in the Registered Mortality. Since this table and those of the Appendix were constructed, however, there

almost with our own. The Strand, with an unusually high death-rate, still had much fewer deaths than Holborn or St. Giles'. St. Martin's and St. Marylebone were close on the average of London, and St. Pancras was the only one of the districts under review that held a better position than that average. The death-rates of these districts, in 1862, are compared with those witnessed in former years in the subjoined Table.

Death-rate per 10,000* in St. Giles's and neighbouring Districts.

DISTRICTS.	1857.	1858.	1859.	1860.	1861.	1862.
St. Pancras ...	197·0	224·9	221·4	208·7	228·3	215·5
St. Marylebone	217·3	224·0	225·0	227·7	242·5	237·1
Metropolis......	221·0	234·4	227·0	224·1	231·8	234·1
Holborn.........	236·3	247·7	248·6	238·7	270.4	285·5
Strand	239·4	226·6	262·9	231·5	233·7	254·6
St. Martin	243·0	218·5	246·7	228.6	233·7	238·0
St. Giles's.......	280·0	258·2	260·1	262·4	270·3	289·0

* Correction is here made for the longer duration of the registration year, 1857. Also for all deaths in hospitals and outlying workhouses.

SECTION III.—On the causes of Death in St. Giles' District.

Passing from the consideration of the gross mortality of St. Giles' to investigate the particular diseases that caused it, it is instructive first to examine them side by side with the same diseases as prevailing in other parts of London. The population of St. Giles' in 1862, being 1÷ 52·6th part of that of the whole metropolis, this proportion of deaths from each class of causes would be expected to fall to our share. Some diseases, however, show a higher mortality than this quota, while others were fatal to less than the calculated degree.

Zymotic Diseases have of course the first interest for us. They are the class of disorders whose prevention has been regarded as specially within the province of sanitary science, and they form one of the chief groups of diseases from which St. Giles' suffers to a greater degree than other parts of London. In 1862, the miasmatic order of these diseases produced 327 deaths in St. Giles', a slight excess above the average number of recent years. Comparing this number with the quota for St. Giles' population in the year, the excess is about what is generally observed.

The mortality of London at large, from this group of disorders, was such that 310 deaths would have been reckoned to our population. The actual deaths were therefore, on this standard, in some but not in considerable excess. Small Pox caused only four deaths.* Measles and Scarlatina increased much in prevalence through the year in St. Giles', as elsewhere in London, but Measles produced fewer deaths, while Scarlatina caused a few more than would be calculated for the population. While Diphtheritis was little fatal to our district, Croup† is stated to have caused 26 deaths instead of the estimated quota of 18. Whooping Cough affected St. Giles' much like the rest of London. Diarrhœa was singularly little fatal, only 25 deaths being returned from it—the

* Again it must be noted that some deaths of ricketty children, where "crowing respiration" appears as a main symptom, are probably inserted under this head. Such deaths would be likely to happen with particular frequency in St. Giles'.

† There is some doubt about one of these cases; in the distribution of mortality into localities, three Small-pox deaths only could be placed.

smallest number recorded for many years. The various forms of Continued and remittent fever caused 93 deaths, the average of the five preceding years being only 39. The increase of 54 deaths was doubtless due to the reappearance of true Typhus, which had been absent from St. Giles' for several years, as absolutely as from the rest of the town.*

Typhus being a disease that affects the poor classes especially, it is of interest to note that of the 93 fever deaths, 27 occurred in the workhouse, and 7 were among parishioners of St. Giles' and Bloomsbury who had been taken to neighbouring hospitals. Of these 34 fever deaths in public institutions, 29 were recorded as being "typhus." The other 25 deaths that may be reckoned as resulting from this particular form of contagious fever, took place in the houses of the district.

The great group of *Consumptive or Tubercular* diseases, always reckons in St. Giles's more victims than in an equal population of the rest of London. The excess in 1862, was somewhat greater than usual—297 deaths from these causes being registered instead of the estimated quota of 201. That our population is ill-fed and ill-housed beyond the average of other districts appears the cause of this disproportionate mortality.

Diseases of the several parts and organs of the body form the third class of causes of death. In St. Giles', as usual, a large mortality was witnessed in 1862, from *Diseases of the Brain*. Many of these diseases, but especially infantile convulsions, depend upon causes that are particularly common in the poor of St. Giles. Bad management and improper feeding of infants is the great cause of convulsions among them. In the adult, intemperance adds much to the prevalence of this set of diseases.

A large mortality from *Heart Disease*, again, is a usual feature of the death-rate of St. Giles'. This year the excess has been marked, but not in a degree that requires detailed comment.—It is the important class of *Diseases of the Breathing Organs* that demands our most earnest attention. From these diseases, St. Giles' lost 346 inhabitants against an estimated number of 213. This is the largest mortality from such causes that has been ever recorded in their reports. The excess is alike, as far as can be seen, in the acute and chronic forms of lung disease. It affected males (as is generally the case, but still especially so this year), considerably more than females, and fell chiefly of course, on the colder quarters of the year. In these circumstances are indicated the chief causes why St. Giles' suffers especially from such complaints. A poor labouring population cannot avoid exposure to all sorts of weathers, and is often not fortified by adequate clothing and food to resist its inclemencies. But why the district has suffered more in 1862 than usual from these lung complaints is not so easily explained.

In the class of *Developmental diseases*, the experience of St. Giles' in 1862 is identical with that of former years. A large excess in the mortality of its children is observed from the causes that are reckoned under this head. The number of children prematurely born seems, not unexpectedly, to be very high in St. Giles'. And weakly children, succumbing to small ailments in the course of their teething, also swell high the number of deaths referred

* In certificates that are given by medical practitioners as to the cause of death, it often happens that the nature of a fever is not properly designated. Thirty-six of the 90 deaths only were registered as occurring from Typhus. There is no doubt, however, that many of the deaths returned under vague designations (perhaps some of those returned as Typhoid), were real cases of Epidemic Typhus.

Comparison of Mortality from various causes in London and in Saint Giles'. Whole Year, 1862.

Classes.	Classes and Orders of Disease.	London. Population, 2,859,778.	St. Giles's, Population, 54,026. Estimated Quota.*	Actual *Registered* Mortality.	Corrected for Deaths in Hosptls.
	All Causes	66350	1273·0	1483	1563
	Specified Causes	66075	1256 3	1462	1539
	Classes				
I.	Zymotic Diseases	17869	339·7	344	357
II.	Constitutional "	12903	245·5	321	342
III.	Local "	25423	483·3	596	629
IV.	Developmental "	7671	145·8	175	177
V.	Violent Deaths	2209	42·0	26	34
	Orders.				
I.	1 Miasmatic Diseases	16678	309·9	314	327
	2 Enthetic "	343	6·5	15	15
	3 Dietic "	706	13·5	12	12
	4 Parasitic "	142	2·7	3	3
II.	1 Diathetic Diseases	2329	44·6	40	45
	2 Tubercular Diseases	10574	200·9	281	297
III.	1 Diseases of Nervous System	6924	131·6	139	146
	2 " Organs of Circulation	2993	56 9	57	67
	3 " Respiratory Organs	11190	212·8	337	346
	4 " Digestive Organs	2745	52·2	43	48
	5 " Urinary Organs	958	18·2	13	15
	6 " Organs of Generation	203	3·8	4	4
	7 " Organs of Locomotion	184	3·5	3	3
	8 " Integumentary Organs	226	4·3	...	...
IV.	1 Dev: Dis. of Children	1964	37 4	62	62
	2 " " Adults	252	4·8	6	6
	3 " " Old People	2631	50·0	53	54
	4 Diseases of Nutrition	2819	53 6	54	55
V	1 Accident or Negligence	1829	34·8	23	31
	4 Suicide	266	5·0	2	2
	All other Violent Deaths	114	2·2	1	1
	Sudden Deaths	256	4·9	...	...
	Cases unspecified	619	11·8	21	24
	Certain Special Diseases of Zymotic Class and Miasmatic Order.				
I.1.	Small Pox *	345	6·5	4	4
	Measles	2281	43·4	37	37
	Scarlatina	3457	65·7	68	70
	Diphtheritis	734	13·9	7	9
	Croup	937	17·8	24	26
	Whooping Cough	2150	40·9	42	42
	Diarrhœa	1735	32·9	25	25
	Typhus & other Fevers, continued and remittent	3742	71·1	86	93

* 1 ÷ 52·6th part of the entire mortality of the Town. As to the exact number of Deaths registered in the District, see note (*) to table on page 3.

to this class At the other extreme of life, it is again observed that St. Giles' has its full share of persons who die of nothing but old age. One woman is even recorded to have reached the age of 104 years. On the other hand, nine of the persons who are said to have died of old age, had not reached the age of fourscore years and ten, and one woman is registered as dying of "natural decay,"—that was very unnatural—at the age of 50 years.

Of *Deaths from Violence*, it does not appear that so many occurred in St. Giles' as the number of its residents would lead us to expect. On the other hand, deaths from *Causes that were not specified*, or badly defined, were twice as common in our district as in the average of the town, and it is to be feared that among them some deaths occurred that were open to the suspicion of being caused by violence.

To recapitulate then, the high mortality of St. Giles' in the year 1862, resulted firstly, from a small excess (5·5 per cent., and less than the average excess of former years) in the class of miasmatic or contagious diseases, of which typhus fever was the only member contributing an exceptional mortality above other districts. Secondly, from a large excess, (47·8 per cent.) in the important class of consumptive disorders. Thirdly, from a great excess (54·3 per cent.) in the equally important group of lung diseases, acute and chronic; and fourthly, from a great excess (65·8 per cent.) in such children's diseases as are not comprised in the foregoing classes. The causes of the diseases thus in excess are to some extent such as public sanitary measures can deal with, but are to a greater degree dependent on conditions of exposure, destitution, and ignorance, that cannot be dealt with directly by the Officer of Health.

SECTION IV.—On the Localization of Disease and Death in St. Giles' in 1862.

A. In Sub-districts. Before a death-rate can be obtained for each of the sub-districts of St. Giles', correction has to be made for deaths in Hospitals, while deaths occurring in the Workhouse must be considered apart. In so far as the mortality in the Workhouse resulted from recent disease that was taken into the Infirmary for treatment, this mortality may be distributed among the streets from which the patients were brought. These corrections lead to the following results :—

Sub-districts of St. Giles's, Deaths in 1862.

Deaths of residents in sub-district of	Dying at own Homes	Dying in Hospitals.	Dying in Workhouse.	Total.
Bloomsbury	342	18	16	376
St. Giles's South	441	38	116	595
(Workhouse Inmates, &c.)	...	...	108	108
St. Giles's North	404	24	56	484
Whole District	1187	80	296	1563

The death-rate of persons resident in each sub-district, without reference to the place where they happened to die, is therefore, in St. George Bloomsbury, 21·6 per 1000; in St. Giles' South 31·7 per 1000; and in St. Giles' North 28·2 per 1000. Herein the Workhouse with its residents is excluded.

Comparing these figures with the results of former years (and taking the rate per *ten thousand* to avoid fractions) we have the following

Death-rate per 10,000 in Sub-districts.*

DISTRICTS.	1857.	1858.	1859.	1860.	1861.	1862.
St. George, Bloomsbury......	180	198	184	185	205	216
St. Giles's South	357	292	349	346	291	317
St. Giles's North	283	277	240	247	279	282
Whole District...................	280	258	260	262	270	289

* Correction has been made for the extra length of the registration year 1857.

The progressive rise in the mortality of Bloomsbury is only to a small extent accounted for by the increase of its population. The death-rate of St. Giles' South is slightly below the average of the preceding five years, while that of St. Giles' North is (like Bloomsbury) in excess of its usual amount.

Here for convenience of reference it is well to show the *Births* in the same sub-districts, in so far as they have been registered each year.

Registered Births in Sub-districts.

SUB-DISTRICTS.	1857.	1858.	1859.	1860.	1861.	1862.
St. George Bloomsbury	398	403	411	430	416	383
St. Giles's South	860	717	780	786	808	772
St. Giles's North	592	557	538	562	532	583
Whole District..................	1850	1677	1729	1778	1756	1738

B. Reverting, for the more detailed conditions of the localization of disease in St. Giles', to the Ten Localities into which it has been customary in these reports to divide the district, we find that the gross mortality has been distributed in the manner shown by the table on the top of the next page.

Here it may be observed that while most of the localities have contributed to the rise in mortality in 1862, those about Church Lane and Short's Gardens are especially above their numbers of the preceding year, and both now occupy a position even below the neighbourhood of Dudley Street. The order of salubrity of the different localities, on the test of the death-rate, remains much as in former years. About one of the localities, however, special mention must be made. The angle of the parish of Bloomsbury about Coram Street, consisting of the parts to the East of Woburn-place, has habitually a much higher mortality than the rest of the parish. This would be no matter for surprise when we remember that the poorest people live in the

locality in question. But it further appears that of recent years the mortality is seriously increasing there, the deaths for the past six years having been respectively 127, 133, 128, 127, 154, and 164, in this locality.

Ten Sub-divisions of St. Giles's; their order of Mortality from all causes, 1862.

Order of Sequence, 1862.	Locality of	Actual number of Deaths in 1862.				Total Mortality per 10,000
		In Houses.	In Workh.	In Hosptls.	Total.	
Best 1st......	B. Russell-square.........	72	1	2	75	135
2nd.....	A. Bedford-square	64	—	3	67	170
3rd.....	L. Lincoln's Inn-fields...	42	—	3	45	199
4th. ...	D. Bloomsbury-square...	108	1	6	115	218
5th.-6th...	C. Coram-square	145	11	8	164	270
	K. Southern Drury-lane.	112	18	8	138	272
7th.-8th...	H. Northern Drury-lane.	108	44	9	161	310
	F. Dudley-street	245	25	12	282	311
9th....	E. Church-lane............	116	34	11	161	342
Worst 10th.	G. Short's gardens	175	54	18	247	391
	Workhouse Inmates, &c.	—	108	—	108	—
	Whole District	1187	296	80	1563	289

The continually deteriorating state of the Courts about Little Coram Street has probably the main share in the increase of mortality, and it is to be feared that this increase will continue until some thorough sanitary improvements are here made. The Coram Street neighbourhood has already attained the evil distinction of being bracketted with Southern Drury Lane in its mortality.

The Ten Sub-divisions—their Order of Infantile Mortality in 1862.

Order of Sequence, 1862.	Locality of	Deaths among Children in 1862.			Infantile mortality per 10,000 residents.
		Under 2 years.	2 years to 5 years.	Total under 5 years.	
Best...1st.	B. Russell-square	16	6	22	40
2nd	A. Bedford-square	14	10	24	61
3rd....	D. Bloomsbury-square	35	15	50	95
4th.-5th..	L. Lincoln's Inn-fields	16	9	25	110
	H. Northern Drury lane............	43	15	58	112
6th.....	K. Southern Drury-lane............	48	16	64	126
7th.....	C. Coram-street	68	17	85	138
7th.-8th..	G. Short's-gardens	72	25	97	154
	F. Dudley-street	97	47	144	159
Worst 10th...	E. Church-lane........................	49	28	77	166
	Workhouse Inmates, &c...........	18	3	21	—
	Whole District	476	191	667	123

In the above table are shown the districts in the order in which they suffer loss of children. The disproportion between the best and the worst localities in this respect is as usual very striking, four children dying in the poorer parts of St. Giles' to every one that dies in the better parts of Bloomsbury. This difference is only accounted for to a small degree by the different proportion of the children in the two populations. The great bulk of the difference arises from preventible causes, unwholesome circumstances and ignorant management necessarily affecting chiefly the most tender and helpless ages.

The Ten Localities—their Order of Mortality from Zymotic Diseases, *(Miasmatic Order)* 1862.

Order of Sequence, 1862.	Locality of	Deaths from Miasmatic Diseases in 1862.*									Zymotic mortality per 10,000
		All miasmatic diseases.	Small-pox.	Measles.	Scarlet Fever.	Diphtheritis.	Whooping Cough.	Continued fevers, of which ( ) registered as "typhus."	Diarrhœa.	Other miasmatic diseases.	
Best 1st....	B. Russell-square	11	—	2	3	1	1	1 (0)	2	1	18
2-3	D. Bloomsbury-square..	26	—	—	3	1	10	7 (1)	3	2	49
	L. Lincoln's Inn-fields..	11	—	2	2	—	—	4 (2)	—	3	49
4-5-6	H. Northern Drury-la.	27	—	4	7	—	6	8 (5)	1	1	52
	K. Southern Drury-la.	27	2	5	1	1	4	8 (3)	3	3	53
	A. Bedford-square......	23	—	2	*1	1	3	8 (2)	5	3	58
7th.	G. Short's-gardens......	41	—	2	9	—	3	17 (4)	6	4	65
Worst 8-9-10	E. Church-lane..........	34	—	3	9	—	3	13 (5)	3	3	73
	C. Coram-street..........	46	1	11	8	2	6	10 (4)	1	7	75
	F. Dudley-street	70	—	9	24	2	7	18 (5)	3	7	78
	Workhouse Inmates ...	10	—	—	1	—	—	7 (7)	—	2	—
Whole District..................		326	3	40	68	8	42	101 (38)	27	36	60

* The totals will not always be found to correspond exactly with those in Table III. of the Appendix. This arises partly from the different ways in which a complicated disease may be recorded on two occasions; partly from some correction having been made in the one set of Tables, after the other was compiled. In the column of "fevers," puerperal fever is here included.

In the above table it will be seen that measles culminated about Coram Street, scarlatina about Dudley Street, and whooping-cough in the neighbourhood of Bloomsbury Square. But with the exception of scarlet fever and continued fever all diseases, of the zymotic class were less unevenly distributed than usual throughout the district.

Continued fever, including epidemic typhus, was seen especially in the four localities that are at the bottom of the list. In the poor and thickly populated districts of Dudley Street, Short's Gardens, and Church Lane, it is to be expected that this disease, depending as it does on privation and crowding, would attain its maximum of fatality. It was less to be expected that the neighbourhood of Coram Street should stand below both of the Drury Lane localities in its total mortality from fever. Typhus, once produced by the causes just mentioned, spreads with great rapidity by contagion. It is therefore of the utmost importance to get persons suffering from this disease removed whenever possible from their homes. This was done, as has been before stated, in one third of the fatal cases of "fever" and probably in more than half of the fatal cases of true typhus. Probably there would have been a much smaller mortality if the typhus patients had been removed universally from their homes.

With reference to the place into which fever cases are taken for treatment, it has been observed that 27 deaths from fever occurred in the Workhouse, and 7 in various neighbouring Hospitals—none in the London Fever Hospital, the establishment specially devoted to the care of this class of diseases. It is within the province of this report to point out that there is much danger in treating typhus cases in Infirmaries and Workhouses where patients are received suffering from other diseases, and in which the staff of the establishment is not acclimatized to fever. In the Workhouse of St. Giles' and in at least one of the general Hospitals into which our patients were received, typhus in 1862 spread to other inmates in a serious degree. What most concerns our own district is, that in the Workhouse of St. Giles' *seven inmates* died of this fever, being a quarter of the whole number of typhus deaths that occurred in the Infirmary. The seven deaths were mostly among imbecile or infirm persons. This spread of typhus is not peculiar to our Workhouse, but represents very closely the degree to which the disease habitually spreads if it is treated in the same wards with other diseases.* On the other hand, in the London Fever Hospital, in the same epidemic, the deaths among the persons who caught the fever in the wards was only one in 37 of the whole number of deaths. It is much to be hoped that, ~~if~~ fever should continue in our district, the experience of the past year may induce the adoption of a system of rigorous isolation for all cases of contagious typhus.

The Ten Localities—their order of Mortality from Tubercular Diseases, 1862.

Order of Sequence, 1862.	Locality of	Deaths from Tubercular Diseases.			Tubercular Mortality per 10,000.
		From Consumption, Tabes, and Scrofula.	From Water-on-the Brain.	Total.	
Best ...1st....	B. Russell-square..................	11	2	13	23
2nd.	A. Bedford-square	10	1	11	28
3rd. .	D. Bloomsbury-square	16	5	21	40
4th ...	L. Lincoln's Inn-fields	7	3	10	44
5th ...	C. Coram-street	24	4	28	46
6th ...	F. Dudley-street	42	3	45	50
7-8-9	E. Church-lane	27	5	32	68
	K. Southern Drury-lane.......	33	2	35	69
	G. Short's-gardens	40	4	44	69
Worst 10th...	H. Northern Drury-lane.......	37	2	39	76
	Workhouse Inmates	20	—	20	—
Whole District		267	31	298	55

* Thus in six general Hospitals of London into which typhus patients were admitted in 1862, and when the spread of the disease was investigated by Dr. Murchison, it was found that 21 out of 80 deaths from this fever were in nurses or other patients in proximity to the sick.

The deaths from *Tubercular Disease* were as usual very diversely distributed, the poorer parts of St. Giles', in which there are many common lodging houses, suffering to an extreme degree. It has been said that the general mortality of the district from this class of causes was high in 1862. There is nothing worthy of remark in the special distribution of the excess.

The Ten Localities--their order of Mortality from Diseases of the Lungs, 1862.

Order of Sequence, 1862.	Locality of	Deaths from Lung Diseases.			Mortality per 10,000.	
		Acute Bronchitis, Inflammation of Lungs and Pleura.	Chronic Bronchitis and Asthma.	Total.	From acute lung diseases.	From all lung diseases.
Best ...1st....	A. Bedford-square	4	3	7	10	18
2nd...	B. Russell-square	8	4	12	14	22
3rd....	D. Bloomsbury-square ...	12	7	19	23	36
4th....	L. Lincoln's Inn-fields ...	9	1	10	40	44
5th....	K. Southern Drury-lane...	22	6	28	43	55
6th....	C. Coram-street	22	15	37	36	61
7th....	H. Northern Drury-lane...	20	15	35	39	68
8th....	F. Dudley-street	43	23	66	47	73
Worst 9-10	E. Church lane	21	17	38	45	81
	G. Short's-gardens	29	28	57	46	90
	Workhouse Inmates.........	5	28	33	—	—
	Whole District..................	195	147	342	37	63

Here are shewn the neighbourhoods that have suffered most in 1862 from that enormous mortality from *Lung Diseases* that has been seen to characterize our district.

The two districts lowest on the list were also lowest in the preceding year. Again may be observed the vast preponderance of these disorders in the unfortunate districts of St. Giles, where poverty necessitates constant exposure to the vicissitudes of weather, and forbids the system from being adequately protected by clothing and food against the ill effects of such exposure.

The distribution of *Deaths from Violence* needs no particular discussion. It is allotted a column in the following table, where for the first time an investigation is made into the localization of a class of disease which is especially prevalent in our district.

It will be seen from the second column of the subjoined table that *Brain diseases* are much more fatal in the poor districts than in the more prosperous parts. But the third column will prove that this disproportion applies to Brain diseases scarcely otherwise than as it applies to the mortality from all causes. Convulsions in children being so prominent a member of this class of diseases, and all the disorders fatal to children being so especial rife among the poor, this negative result is about what would have been anticipated.

Distribution of Mortality from Brain Diseases in 1862. Also of Deaths from Violence and Intemperance.

In Locality of	Deaths from Brain Diseases. Actual mortality.	Per 10,000 of population.	Per cent. of total mortality.	Deaths from Violence and Intemperance. Actual number in 1862.
A. Bedford-square	4	10	6	2
B. Russell square	8	14	11	1
C. Coram street	10	16	10	1
D. Bloomsbury-square	5	10	11	2
E. Church-lane	18	38	11	2
F. Dudley street	30	33	10½	6
G. Short's-gardens	31	49	12½	11
H. Northern Drury-lane......	14	27	9	8
K. Southern Drury-lane......	10	20	7	6
L. Lincoln's Inn-fields	4	18	9	1
Workhouse Inmates	21	—	19	2
Whole District	155	29	10	42

SECTION V.—**On the Diseases and Deaths in the Practice of the Public Medical Institutions of St. Giles's in 1862.**

In the subjoined tables are furnished numerical data as to the amount of sickness attended by the Medical Officers of the Workhouse and of the Bloomsbury Dispensary.*

New Cases treated at Bloomsbury Dispensary, 1862.

Quarter ending.	Physician's Cases.			Surgeon's cases.			Casualties.	Total.		
	Admitd.	Visited at home.	Died.	Admitd.	Visited at home.	Died.		Admitd.	Visited at home.	Died.
Mar. 25th.	843	213	26	362	66	1	232	1437	279	27
June 24th.	785	146	15	320	52	2	255	1360	198	17
Sept. 29th.	729	148	38	341	48	3	212	1282	196	41
Dec. 25th.	744	193	18	324	80	4	193	1261	273	22
Whole Yr.	3101	700	97	1347	246	10	892	5340	946	107

At the Bloomsbury Dispensary then the total number of patients was almost identical with the number treated in 1861, but a notably greater number of persons required attendance at their own homes. From the nature of the prevailing disorders this would be expected. Affections of the air-passages were observed by the physician to have been strikingly prevalent throughout the year, herein confirming the experience derived from the register of deaths.

* In using these numbers it must be remembered that the proximity of a prevailing disease to one or other of these Institutions is habitually found to bring that disease into special prominence in the records of that Institution.

Cases of Disease and Deaths, occurring in the Practice of the Workhouse in 1862, and its four Quarters.

Cases occurring.	Within Walls of Workhouse. (Infirmary and Inmates.)										Among Out-Patients attending at Workhouse.					Among Patients visited at their own homes.									
Quarters or the Year.	First Quarter.		Second Quarter.		Third Quarter.		Fourth Quarter.		Whole Year.		First.	Second	Third.	Fourth	Whole Year.	First Quarter		Second Quarter.		Third Quarter.		Fourth Quarter.		Whole Year	
Cases.	New Cases.	Deaths.	New Cases.	Deaths.	New Cases.	Deaths.	New Cases.	Deaths.	New Cases.	Deaths.	New Cases. No Deaths.					New Cases.	Deaths.	New Cases	Deaths.	New Cases.	Deaths.	New Cases.	Deaths	New Cases.	Deaths.
Of all Diseases	466	110	365	54	390	55	358	74	1579	293	672	909	1088	1072	3741	512	57	547	30	575	27	689	30	2323	144
Small Pox	...	...	...	...	...	...	1	...	1	...	1	1	...	...	2	1	1	2	...	...	...	...	...	3	1
Measles	1	...	6	...	1	...	2	...	10	...	2	12	17	12	43	7	2	47	...	41	...	65	...	160	2
Scarlet Fever	...	...	..	...	5	1	20	...	25	1	4	4	9	11	28	7	...	9	1	19	5	27	2	62	8
Whooping Cough	2	...	...	...	7	1	...	...	9	1	11	6	3	3	23	5	3	3	...	...	...	4	...	12	3
Diarrhœa	1	...	...	...	1	...	2	...	4	...	49	109	304	173	635	7	*...	6	...	27	...	5	...	45	...
"Fever and Febricula"	12	...	10	...	8	...	7	...	37	...	70	87	105	83	345	77	11	102	7	112	4	66	1	357	23
"Typhus Fever"	134	12	87	5	72	2	66	8	359	27	...	...	...	..	...	2	...	...	*..	10	...	...	...	12	...
Ague	...	...	...	...	...	...	...	...	...	...	...	..	..	...	...	...	...	...	...	...	...	...	...	...	...
Bronchitis (acute and chronic)	61	33	32	12	30	10	71	19	203	74	148	225	197	264	834	65	3	52	2	50	1	105	1	272	7
Inflammation of the Lungs & Pleura	13	4	3	1	4	1	8	2	28	8	7	7	6	6	26	16	5	16	1	14	2	6	2	52	10
Consumptive Diseases	32	19	36	19	30	15	29	15	127	68	9	23	21	11	64	15	9	17	11	15	5	17	9	64	34
Ophthalmia	6	...	3	...	3	...	...	...	12	...	1	1	6	3	11	...	..	...	...	1	...	2	...	3	...

Of epidemic diseases none occurred in a way to require special mention, except that Small-pox began to show itself at the end of the year, after many months total absence. This was the beginning of the epidemic which has since spread so formidably, and it is to be noted that the epidemic shows itself on the books of this Dispensary earlier than in the records of the Workhouse.

In the table on the opposite page is given a summary of the practice of the Parochial Medical Staff in the year 1862.

A decrease will be noted in the number of those patients whose slighter ailments permitted of their attending at the Workhouse. This result was obtained from an almost absolute abeyance of whooping cough,—23 children only having been brought by this disease in 1862 against 424 in 1861.

The class of patients seen at their own homes has much increased since 1861, but as the increase in number is accompanied by a much smaller mortality,* it would appear possible that the present Assistant-Surgeon visits the sick at their homes when suffering from slight ailments more freely than was the practice in 1861. Or the increased prevalence of lung diseases which need to be treated without exposure to the weather, may be the cause why this class of patients was more numerous.

In the Workhouse Infirmary however, the number of patients has not only been unusually high, but the number of deaths has been considerably higher than in other years. In 1862, half as many persons again were admitted into the Infirmary as in 1861, and nearly double the numbers that were admitted in 1858. Lung diseases here again helped materially to swell the numbers, but the principal cause of the increased admissions is found in fevers of various forms. Three hundred and ninety-six patients suffered from continued fever, 359 of them being stated to have had typhus. Against these large numbers there were only 39 fever cases admitted in 1861, and 26 in 1860. It has before been mentioned that several inmates were attacked in the Workhouse by the contagion of typhus, and that 7 of them died. Considering how exceedingly important it is for the treatment of the sick and the prevention of contagion, to remove patients from their close rooms, it cannot be doubted that more advantage was gained than injury done by the removal of these typhus cases to the Infirmary. Still as it is possible (page 11) to get all this advantage without the same risk of contagion to other inmates, by the plan of treating the sick in a special Hospital, it is to be hoped that in future years typhus patients may be sent to the Fever Hospital or into special isolated wards instead of into the Workhouse.

SECTION VI.—On the Deaths in St. Giles's where there was no Certificate of the Cause from a Medical Man or Coroner.

Forty-five deaths were registered in St. Giles' in 1862, and the corpse in each case interred, about which there ought to have been enquiry.

In 36 of these instances there was no medical certificate of the cause of death. In 11 of the 36 cases, this omission is stated to have occurred through the absence of any medical attendant in the fatal illness. In the other 25 cases, it is simply recorded that the alleged cause of death was not certified. Here are samples of this kind of entry.

* The mortality in this class of patients which had averaged $8\frac{1}{2}$ per cent. in the four preceding years, rose in 1861 to 14 per cent.; in 1862 it was only $6\frac{1}{2}$ per cent.

At 31, Colonnade, on December 18th, 1861, the wife of a porter, aged 37, died of "exhaustion from drink," not certified.

At 57, Dudley Street, on February 24th, 1862, a portmanteau maker, aged 50, died of "pain in the stomach;" not certified.

At 11, Little Saint Andrew's Street, on May 21st, 1862, the son of a hatter, aged 3 months, died of "consumption;" not certified.

At 22, Little Earl Street, on June 8th, a domestic servant, aged 25 years, died of "pain in the bowels;" not certified.

At 1, Little Wild Street, on June 15th, a woman aged 21, occupation and cause of death "unknown;" no medical attendant.

At 31, Dudley Street, on September 29th, the daughter of a tailor, aged 9 weeks, died of "convulsions;" not certified.

It is intolerable in a civilized country parading its respect for human life that persons dying in this way should be interred without any scruple or enquiry. In at least two of these cases there is prima facie ground for suspecting poison. Again, there were no fewer than 20 infants, under a week old, whose deaths were registered in 1862, as occurring from "premature birth," "convulsions," and so forth, without a particle of medical evidence of the cause.

"The Alarming Increase of Infanticide" that we read of daily in the papers is encouraged by nothing so much as by the scandalous facility with which burial certificates may be obtained in the present state of the law.

Furthermore, if the law is careless as to the manner in which people die, it is not surprising that there is carelessness in obeying its scanty provisions relating to the registration of death. In February, 1862, the Registrar of Bloomsbury received information that on the 24th of the preceding December a man aged 36, a domestic servant, had died at 3, Bedford Square; that he was removed from the house to the undertaker's immediately after death, and was buried in the Roman Catholic Cemetery at Kensal Green. No notice had ever been sent to the Registrar (as required by law) of the burial without his certificate. The informant, one of the deceased's fellow servants, could not state the cause of death, and did not know what had become of the medical certificate. Similar cases to this have occurred in former years.

There is another class of Deaths, where the deceased has been seen by a medical practitioner, that equally require an investigation into the cause of death. Nine persons were certified in 1862 to have died of an "unknown" cause, the object of the surgeon who certified being (probably in all instances) that further enquiry should be made.

Eight out of these nine deaths are entered on the registers of the Workhouse as follows :—

Jan. 25. A man, aged 65, "dying when admitted;" certified.
Feb. 11. A woman, aged 29, "dying when admitted;" certified.
Mar. 22. A child, aged 4 months, "found dead;" certified.
April 7. A woman, aged 58, "unknown;" certified.
July 2. An infant, aged 4 days, "asphyxia, found dead;" certified.
Sept. 26. A woman, aged 63, "dying when admitted;" certified.
Oct. 3. An infant, aged 3 weeks, "died in the street;" certified.
Dec. 17. A man, aged 60, "dying when admitted;" certified.

Every one of these deaths was however registered, a certificate for burial given, and the body interred. Now in every one of these cases the law should have provided for information being sent to the Coroner, and none of these bodies should have been buried without his warrant. Whenever a Registrar

receives information of a death concerning whose cause there is no medical certificate, or receives a medical certificate in which the cause of death is not satisfactorily specified, and generally in all cases of doubt, it ought to be his function to communicate with the Coroner. Enquiry is needed in such cases, not necessarily for the purpose of criminating anybody, but with the object of getting at the real cause of such deaths. By the Coroner's enquiry not only is a moral influence exercised to restrain crime, and in many cases are groundless suspicions allayed, but important information is obtained and diffused that leads to the prevention, in other instances, of disease, of violence and of death.

SECTION VII.—On the Sanitary Work of 1862.

It appears now by the experience of several past years that about a ninth part of the houses in the district of St. Giles's come under the charge of the Sanitary Inspector every year. Inasmuch as few better class houses are included in his inspection, the 532 houses improved in 1862 represent a continuance of supervision of the poorer streets and courts of the district, that is tolerably thorough and efficient. The total of 1,724 nuisances about houses abated during the year, includes improvements in drainage and cleanliness, and in the necessaries surrounding the several dwellings. Increased attention has been paid to the ventilation of dwelling-rooms, particularly such as are situate over stables in mews.

House Improvements in St. Giles's, effected under the superintendence of Inspector Webb, between March 25th. 1862, and March, 25th, 1863.

	Number of houses improved	532
Improvements in Drainage.	Drains constructed	111
	Improved or repaired	90
	Traps fixed	219
	Cesspools abolished	39
	Stables drained and horse-pools abolished	45
In Water Closets.	Pan, trap, and water provided	46
	Water and apparatus only provided	170
	Cleaned or repaired	135
	Newly constructed or re-built	18
In Dust Bins.	Newly constructed	18
	Repaired or covered	44
Paving.	Re-laid	75
In General Water Supply.	Receptacles provided	30
	Receptacles repaired	66
	Water provided where none in house before	6
In Cleanliness and Repair.	Generally repaired	30
	Cleansed and lime-whited	320
	Various accumulations removed from cellars, &c.	73
In Ventilation, &c.	Ventilation improved	140
	Overcrowding reduced	20
	Kitchens disused, or made legally habitable	25
	Other rooms disused	4
Proceedings taken.	First notices	312
	Second notices, letters, &c.	96
	Summoned	3
	Reported to Police or District Surveyor	36
	Total Improvements	1724

New Public Sewers have been constructed in the course of 1862, in Nottingham Court, in Ashlins Place and in Whetstone Park; in each instance houses on the line of the new sewer have been connected therewith with very great advantage to their wholesomeness. An important new sewer has also been lately constructed to Keppel Mews South.

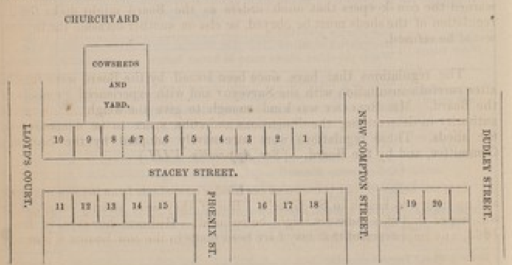
Among places whose sewerage requires early consideration may be mentioned Dudley Street, New Compton Street, and Lincoln Court. In none of these streets can the houses now be drained with complete efficiency, owing to the defects of the central sewer. In Dudley Street, the sewer has been partially repaired, but it is understood still to be very inadequate to the requirements of the street.

As far as practicable, the occupation has been prevented of those underground dwellings of the district that are not in conformity with the provisions of the Metropolis Local Management Act. A little more obedience has been shewn to the law by the parties interested since the enforcement of a penalty against the owners of certain cellars in Dudley Street.

An inspection of the School Children of St. Giles's and Bloomsbury with reference to their Vaccination has been made, but a statement of the results will come with more interest into the next report, when the epidemic of Small Pox in 1863 will have to be noticed. Here it may be said, however, that the proportion of un-vaccinated children detected was much less than on the occasion of the former inspection in 1859.

In the year 1862, an amendment of the law, (25 & 26 Vict., cap. cii. s. 93) gave to Justices of the Peace the power of licensing places to be used as Cow-houses in London, and provided that the District Board might shew cause against the granting of such license. The Board of Works of St. Giles's determined to oppose the granting of any license to Cow-houses within their district, on the ground that their establishments could not be conducted in crowded neighbourhoods without injury to the health of human residents.

Other arguments might easily be adduced against London Cow-houses, viz., that the milk of the animals in London sheds was not as wholesome as that of cows in country pastures; and further, that Central London could easily be supplied with milk from the country; but the main point that appeared needful



to be established in evidence before the Magistrates was that injury was inflicted on the health of the neighbourhood by the presence of Cow-sheds in St. Giles's. To those who had been engaged in observing the sanitary state of the people through a series of years, this did not appear at all doubtful, but it seemed desirable to get, if possible, some numerical proof of such injury to health. With this view, the sanitary statistics of nearly six years (the whole time for which the returns have been furnished by the Registrar-General) were examined with reference to one particular Cow house, that in Stacey Street, which was so situated that its influence on health could be measured. The end of Stacey Street, at which the Cow-house is situate, would be expected, prima facie, to have sanitary advantages over the other end, which abuts on the middle of Dudley Street, a neighbourhood which the readers of these reports will know to be unhealthy beyond most other parts of the Parish of St. Giles. Now on analysis of the mortality it was found that, three houses excepted, there had been an average of 3 deaths in each inhabited house, and in none, a higher mortality than 6 in the six years. But in the three houses, Nos. 6, 7 and 9, there had been an average mortality of 10 deaths each, viz., in No. 6, 7 deaths; in No. 9, 9 deaths; and in No. 7, actually 14 deaths in the period under examination. Now No 7 is the house most directly connected with the Cow-sheds; Nos. 6 and 9 are the two houses flanking it, as will be seen on the diagram given above; No. 8 consists only of workshops and the entrance to the cow-yard. In these three houses, Nos. 6, 7 and 9, 30 deaths occurred, while the other 14 inhabited houses had only 40 deaths between them. The only two fever deaths in the street were in these houses abutting on the cow-yard. Three out of the 5 deaths from diarrhœa were in them. Out of 10 deaths from acute lung disease, which follow (as has been often shewn) the zymotic diseases in their distribution, and depend upon similar impurity of air, eight occurred in these three houses.

The Stacey Street cow-house was the only one in which a numerical estimate was attempted of the influence on the health of the neighbourhood. But on the strength of the facts here ascertained, the reply was not difficult to the question of the counsel who had been retained in the interests of these nuisances,—"Do you mean to say that a cow-house and yard is more detrimental to the health of a neighbourhood than if the same space were covered with poor houses?" "Yes, it positively is so."

Nevertheless, the Magistrates were unwilling to interfere with established trade so far as to abolish altogether the cow-houses of St. Giles's. But they warned the cow-keepers that such orders as the Board might make for the regulation of the sheds must be obeyed, or else on another occasion the licenses would be refused.

The regulations that have since been issued by the Board were framed after careful consultation with the Surveyor and with experienced members of the Board. Mr. Bellamy was kind enough to give the weight of his great authority in determining the dimensions and cubic space to be demanded in the sheds. These regulations were successively adopted by the Sanitary Committee, and by the Board. (*See Appendix VIII.*)

It is not believed that these rules can hinder cow-sheds from being a nuisance and an injury to health in St. Giles's. But if they were strictly observed, it was hoped that this nuisance might be reduced. Hitherto however, in June, 1863, any improvement that may have been made in the cow-houses is scarcely appreciable. The decision of the Magistrates that retained the cowhouses seems to have been construed by most of their proprietors into an assertion of their right to continue the nuisance of their establishments unmolested. One at least of the sheds is actually in a worse state than before the recent regulations were issued. This defiance of authority appears another argument for suppressing, instead of attempting to regulate, the nuisance of cow-houses in St. Giles's.

GEORGE BUCHANAN.

75, Gower Street.
June, 1863.

APPENDIX.

TABLE I.—Mortality per Thousand in London, in the Divisions of London, and in St. Giles's in 1862 and in preceding Years.

Note.—The numbers are computed on an estimate of the population of the period named, and comparison made throughout from the printed returns of the Registrar General.

	Mean of Ten years 1847 to 1856.	Death-rate of Five last years, each corrected to 365¼ days.					
		1857.	1858.	1859.	1860.	1861.	1862.
London	24·46	22·07	23·98	22·77	22·57	23·26	23·49
West Districts.—(Kensington, Chelsea, St. George, Hanover-Square, Westminster, St. Martin, St. James)	22·76	20·86	22·44	21·50	22·24	22·5	22·21
North Districts.—(Marylebone, Hampstead, Pancras, Islington, Hackney)	22·15	21·16	22·96	21·74	21·24	22·4	21·96
Central Districts—St. Giles Strand, Holborn, Clerkenwell, St. Luke, East London, West London, London City)	24·35	23·40	24·55	24·22	23·42	25·11	25·78
East Districts—(Shoreditch, Bethnal Green, Whitechapel, St George East, Stepney, Poplar)	25·84	24·24	25·87	24·03	24·16	24·11	25·92
South Districts.—St. Saviour, St. Olave, Bermondsey, St. George Southwark, Newington, Lambeth, Wandsworth, Camberwell, Rotherhithe, Greenwich, Lewisham.)	26·28	21·15	24·04	22·69	22·22	22·87	22·61
St. Giles's	26·89	26·58	24·89	24·94	24·98	25·55	27·40

TABLE II.—Deaths in Hospitals among Patients brought from St. Giles's and neighbouring Districts, 1862.

Districts.	Total ascertained Deaths in London Hospitals.	Kings College Hospital, (Strand).	Middlesex Hospital (Marylebone).	Charing Cross Hospital (St. Martins)	University College Hospital (St. Pancras)	Children's Hospital (Holborn).	St. Bartholomew's Hospital (W. London)	Royal Free Hospital (St. Pancras).	London Fever Hospital (Islington).	Westminster Hospital (Westminster).	St. Mary's Hospital (Paddington).	Deaths in Hospital out of the district.
St. Pancras	224	12	45	1	**83**	18	12	**15**	38	...	...	126
St. Marylebone	221	4	**81**	1	23	4	6	3	42	..	57	140
Metropolis	3857	159	268	81	155	73	633	95	466	186	168	...
Holborn	99	21	2	4	4	**4**	32	2	30	...	...	95
Strand	97	**52**	10	17	2	2	2	0	12	...	...	45
St. Martin's	45	11	0	**14**	0	1	1	0	18	0	...	31
St. Giles's	80	18	26	13	9	6	8	0	0	0	...	80

The figures in the above table were obtained by personal inspection of the books of the several Hospitals, with the exception of those marked with a star, and for these I have to thank Dr. Thompson, and Mr. Beale, the Officers of Health of the respective districts.

TABLE IV.—Comparison of Mortality from various causes in London, and in St. Gi[les] Four Quarters, 1862.

Class.	Classes and Orders of Disease.	First Quarter. London.	First Quarter. St. Giles. Estimated Quota.	First Quarter. St. Giles. Actual Number.	Second Quarter. London.	Second Quarter. St. Giles. Estimated Quota.	Second Quarter. St. Giles. Actual Number.	Third Quarter. London.	Third Quarter. St. Giles. Estimated Quota.	Third Quarter. St. Giles. Actual Number.	Fourth Q[uarter]. London.	Fourth Q[uarter]. St. [Giles]. Estimated Quota.
	All Causes	18405	350·0	433	15695	298·3	369	15133	287·6	370	17717	[illegible]
	Specified Causes...	18046	343·0	421	15482	294·3	364	14985	284·8	368	17562	[illegible]
	(Classes.)											
I.	Zymotic Diseases	4174	79·3	89	3919	74·5	75	4721	89·7	96	5055	[illegible]
II.	Constitutional „	3345	63·6	90	3390	67·4	85	3017	57·3	99	3151	[illegible]
III.	Local „ ...	7747	147·3	190	5078	108·0	130	4953	94·1	137	6955	[illegible]
IV.	Developmental „	2198	41·8	43	1839	34·9	56	1749	33·2	38	1894	[illegible]
V.	Violent Deaths	591	11·2	9	566	10·7	9	545	10·3	7	507	[illegible]
	(Orders.)											
I.	1. Miasmatic Diseases	3901	74·2	82	3626	68·9	68	4396	83·5	86	4735	[illegible]
	2. Enthetic „	84	1·6	3	87	1·6	5	78	1·4	4	94	[illegible]
	3. Dietic „	169	3·2	3	165	3·1	2	197	3·7	4	175	[illegible]
	4. Parasitic „	20	·4	1	41	·7	...	50	·9	2	31	[illegible]
II.	1. Diathetic „	614	11·7	6	587	11·1	12	573	10·9	17	555	[illegible]
	2. Tubercular „	2731	51·9	84	2803	53·3	73	2444	46·4	73	2596	[illegible]
III.	1. Dis. of Nervous Syst.	1978	37·6	47	1669	31·7	29	1592	30·2	41	1685	[illegible]
	2. „ Organs of Circulation	848	16·1	24	711	13·5	18	614	11·6	10	820	[illegible]
	3. „ Respiratory Organs	3828	72·8	100	2343	44·5	76	1688	32·0	66	3331	[illegible]
	4. „ Digestive ditto	697	13·2	12	647	12·3	11	707	13·4	15	694	[illegible]
	5. „ Urinary ditto	260	4·9	4	231	4·4	5	213	4·0	2	254	[illegible]
	6. „ Organs of Generation	59	1·1	2	53	1·0	...	41	·7	1	50	[illegible]
	7. „ „ Locomotion	29	·5	1	60	1·1	...	47	·9	2	48	[illegible]
	8. „ Integumentary System	48	·9	...	54	1·0	...	51	1·0	...	73	[illegible]
IV.	1. Dev. Dis. of Children	577	10·9	15	512	9·7	24	427	8·1	12	456	[illegible]
	2. „ „ Adults......	71	1·3	2	69	1·3	1	58	1·1	1	54	[illegible]
	3. „ „ Old People	854	16·2	15	575	10·9	9	513	9·8	14	683	[illegible]
	4. Diseases of Nutrition	687	13·0	11	683	13·0	22	745	14·1	11	704	[illegible]
V.	1. Accdt. or Negligence	500	9·5	9	452	8·6	9	449	8·5	6	428	[illegible]
	2. Suicide	61	1·1	...	81	1·5	...	70	1·3	1	54	[illegible]
	All other Violent Dths.	30	·5	...	33	·6	...	26	·5	...	25	[illegible]
	Sudden Deaths	46	·8	...	64	1·2	...	55	1·0	...	55	[illegible]
	Cause unspecified ...	55	1·0	12	149	2·8	5	93	1·7	2	100	[illegible]
	Certain Special Diseases.											
I.	Small Pox	37	·7	1	39	·7	1	77	1·4	...	192	[illegible]
	Measles	235	4·4	7	501	9·5	7	645	12·2	11	900	[illegible]
	Scarlatina	774	14·7	10	677	12·8	6	841	15·9	26	1165	[illegible]
	Diphtheritis	216	4·1	2	172	3·2	3	144	2·7	1	202	[illegible]
	Croup	284	5·4	6	193	3·7	5	220	4·1	8	240	[illegible]
	Whooping Cough	814	15·5	22	519	9·8	12	327	6·2	3	490	[illegible]
	Diarrhœa	171	3·2	4	217	4·1	1	956	18·1	14	391	[illegible]
	Typhus and other Fevers, continued & remittent	1015	19·3	21	1046	19·8	30	848	16·1	20	863	[illegible]

Deaths in Hospitals here included. Population of St. Giles, 1 ÷ 52·3 part of the Populati[on of] London in 1862.

[...]s in Orders.

20 and under 25.	25 and under 35.	35 and under 45.	45 and
...	...	1	
...	..	...	
...	1	...	
...	1	...	
...	...	...	
...	...	...	
...	...	...	
5	10	18	
...	1	...	
1	2	2	
...	...	...	
...	...	...	
...	...	...	
...	1	1	
...	...	...	
...	...	...	
...	...	...	
...	...	1	
...	...	..	
...	...	...	
...	...	...	
...	...	..	
...	...	...	
...	1	3	

L	Lincoln's-inn-fields	308	2261
	Workhouse	1	695
	Total	4675	54,049

Here Eve Terrace, Old St. Pancras Road (thirteen houses and eighty-eight residents) is, for brevity's sake, included in locality A. The enumerators' returns, on which this Table is based, were kindly furnished by the Registrar-General.

TABLE III.– Causes of Deaths in St. Giles's in 1862, with the Ages at Death.

(Deaths in Hospitals are here included.)

Class.	Causes of Death.	At all Ages. Males.	Femls.	Total.	Under 2 years.	2 and under 5.	5 and under 10.	10 and under 20.	20 and under 25.	25 and under 35.	35 and under 45.	45 and under 55.	55 and under 65.	65 and under 75.	75 and under 85.	85 and upwards.
	All causes	814	749	1563	476	191	55	44	43	108	145	150	141	126	72	12
	Specified causes	805	736	1539	467	191	54	44	42	106	144	146	136	125	72	12
	(Classes.)															
I.	Zymotic Diseases	188	169	357	125	104	25	14	6	17	27	17	17	3	2	...
II.	Constitutional "	171	171	342	56	29	13	20	25	64	57	40	22	13	3	...
III.	Local "	347	282	629	160	47	15	9	9	21	52	86	93	99	35	3
IV.	Developmental "	78	99	177	109	7	1	...	...	2	4	1	3	10	31	9
V.	Violent Deaths	19	15	34	17	4	...	1	2	2	4	2	1	...	1	...
	(Orders.)															
I.	1 Miasmatic Diseases	168	159	327	105	104	24	14	6	16	23	14	16	3	2	...
	2 Enthetic "	10	5	15	15	...	...	...	...	...	...	...	...	...	...	...
	3 Dietic "	9	3	12	3	...	...	...	...	1	4	3	1	...	...	...
	4 Parasitic "	1	2	3	2	..	1	...	...	...	...	...	...	...	...	...
II.	1 Diathetic "	18	27	45	1	2	...	1	...	1	6	10	10	11	3	...
	2 Tubercular "	153	144	297	55	27	13	19	25	63	51	30	12	2	...	...
III.	1 Diseases of Nervous System	76	70	146	43	10	5	1	4	5	12	24	16	19	6	1
	2 " of Organs of Circulation	36	31	67	...	...	...	1	1	4	16	18	13	5	9	...
	3 " of Respiratory Organs	208	138	346	108	32	8	4	2	8	17	31	54	66	14	2
	4 " of Digestive Organs	18	30	48	9	3	1	2	2	3	4	8	6	6	4	...
	5 " of Urinary Organs	8	7	15	...	2	1	...	...	...	2	3	2	3	2	...
	6 " of Organs of Generation	...	4	4	...	...	...	...	...	1	1	1	1	...	...	...
	7 " of Organs of Locomotion	1	2	3	...	...	...	1	...	...	...	1	1	...	...	...
	8 " of Integumentary System	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
IV.	1 Dev. Diseases of Children	29	33	62	60	2	...	...	...	...	...	...	...	...	...	...
	" of Adults	...	6	6	...	...	...	...	...	2	4	...	...	...	...	...
	" of Old People	18	36	54	...	...	...	...	...	...	...	1	3	10	31	9
	4 Diseases of Nutrition	31	24	55	49	5	1	...	...	...	...	...	...	...	...	...
V.	1 Accident or Negligence	17	14	31	16	4	...	...	2	2	4	1	1	...	1	...
	3 Homicide	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...
	4 Suicide	2	...	2	...	...	...	1	...	...	...	1	...	...	...	...
	5 Execution	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Violent Deaths not classed	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Sudden Deaths, cause unascertained	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Causes not specified or ill-defined	11	13	24	9	...	1	...	1	2	1	4	5	1	...	...

TABLE III—(continued.) Diseases in Orders.

Class.	Causes of Death.	At all Ages. Males.	Females.	Total.	Under 2 years.	2 and under 5.	5 and under 10.	10 and under 20.	20 and under 25.	25 and under 35.	35 and under 45.	45 and under 55.	55 and under 65.	65 and under 75.	75 and under 85.	85 and upwards.
I.	Order 1.															
	1 Small Pox	2	2	4	3	...	...	...	...	...	1	...	...	...	...	...
	2 Measles	17	20	37	22	15	...	...	...	...	...	...	...	...	...	...
	3 Scarlatina	34	36	70	18	35	12	3	...	1	...	1	...	...	...	...
	4 Diphtheritis	4	5	9	3	3	1	...	...	1	...	...	1	...	...	...
	5 Quinsy	2	...	2	1	1	...	...	...	...	...	...	...	...	...	...
	6 Croup	15	11	26	6	19	1	...	...	...	...	...	...	...	...	...
	7 Whooping Cough	20	22	42	25	13	4	...	...	...	...	...	...	...	...	...
	8 Continued Fevers, Typhus, &c.	49	41	90	2	14	6	10	5	10	18	10	13	2	...	...
	9 Erysipelas	5	1	6	3	...	...	...	...	1	...	...	2	...	...	...
	10 Metria	...	6	6	...	...	...	1	1	2	2	...	...	...	...	...
	11 Carbuncle	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12 Influenza	1	1	2	...	...	...	...	...	...	...	1	...	...	1	...
	13 Dysentery	...	2	2	...	1	...	...	...	...	...	1	...	...	...	...
	14 Diarrhœa	14	11	25	20	1	...	...	...	1	1	...	...	1	1	...
	15 Cholera	1	...	1	1	...	...	...	...	...	...	...	...	...	...	...
	16 Ague	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17 Remittent Fever	2	1	3	1	2	...	...	...	...	...	...	...	...	...	...
	18 Rheumatism	2	..	2	...	...	...	...	...	...	1	1	...	...	...	...
	Order 2.															
	1 Syphilis	10	5	15	15	...	...	...	...	...	...	...	...	...	...	...
	2 Stricture of Urethra	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Order 3.															
	1 Privation	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	2 Want of Breast Milk	2	1	3	3	...	...	...	...	...	...	...	...	...	...	...
	3 Puerpera and Scurvy	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4 Alcoholism.—															
	a Delirium Tremens	7	...	7	...	...	...	...	...	1	3	3	...	...	...	...
	b Intemperance	...	2	2	...	...	...	...	...	...	1	...	1	...	...	...
	Order 4.															
	1 Thrush	1	1	2	2	...	...	...	...	...	...	...	...	...	...	...
	2 Worms	...	1	1	...	...	1	...	...	...	...	...	...	...	...	...
	Order 1.															
II.	1 Gout	1	...	1	...	...	...	...	...	...	...	...	...	1	...	...
	2 Dropsy	6	1	7	...	...	...	...	...	...	1	1	2	1	2	...
	3 Cancer	8	24	32	...	...	...	...	...	1	5	9	8	8	1	...
	4 Noma	2	1	3	1	1	...	...	...	...	...	...	...	...	...	...
	5 Mortification	1	1	2	...	...	...	1	...	...	...	...	...	1	...	...
	Order 2.															
	1 Scrofula	11	10	21	9	9	2	...	...	...	1	...	...	...	...	...
	2 Tabes Mesenterica	15	9	24	19	4	1	...	...	...	...	...	...	...	...	...
	3 Phthisis	105	117	222	9	5	9	17	25	63	50	30	12	2	...	...
	4 Hydrocephalus	22	8	30	18	9	1	2	...	...	...	...	...	...	...	...
	Order 1.															
III.	1 Cephalitis	2	6	8	2	2	3	...	...	...	1	...	...	...	...	...
	2 Apoplexy	11	12	23	...	...	...	...	1	2	2	9	3	4	1	1
	3 Paralysis	14	20	34	...	...	...	...	...	2	3	5	10	10	4	...
	4 Insanity	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	5 Chorea	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	6 Epilepsy	9	5	14	...	1	...	...	2	...	1	7	1	1	1	...
	7 Convulsions	26	20	46	39	7	...	...	...	...	...	...	...	...	...	...
	8 Other Brain Diseases	10	11	21	2	...	2	1	1	1	5	3	2	4	...	...
	Order 2.															
	1 Pericarditis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	2 Aneurism	1	...	1	...	...	...	...	...	...	...	1	...	...	...	...
	3 Heart Disease, &c.	35	31	66	...	...	...	1	1	4	16	17	13	5	9	...
	Order 3.															
	1 Laryngitis	2	1	3	3	...	...	...	...	...	...	...	...	...	...	...
	2 Bronchitis	132	91	223	47	15	4	1	1	3	7	25	47	61	11	1
	3 Pleurisy	4	2	6	1	...	...	...	...	1	...	2	1	...	...	1
	4 Pneumonia	61	39	100	57	17	4	3	1	3	6	3	3	2	1	...
	5 Asthma	7	3	10	...	...	...	...	...	1	1	1	3	2	2	...
	6 Other Lung Diseases	2	2	4	...	...	...	...	...	...	3	...	...	1	...	...

TABLE III. Diseases in Orders—(continued.)

Class.	Causes of Death.	At all Ages. Males.	Females.	Total.	Under 2 years.	2 and under 5.	5 and under 10.	10 and under 20.	20 and under 25.	25 and under 35.	35 and under 45.	45 and under 55.	55 and under 65.	65 and under 75.	75 and under 85.	85 and upwards.
	Order 4.															
	1 Gastritis	...	4	4	2	1	...	...	...	...	...	1	...	...	...	...
	2 Enteritis	3	5	8	2	1	...	...	1	...	1	2	...	1	...	...
	3 Peritonitis	1	3	4	1	...	1	...	...	...	...	...	1	1	...	...
	4 Ascites	1	1	2	...	...	...	...	...	1	...	...	1	...	...	...
	5 Ulcer. Intest.	1	...	1	...	...	...	...	...	...	1	...	...	...	...	...
	6 Hernia	2	2	4	...	...	...	...	...	...	...	...	2	1	1	...
	7 Ileus	1	...	1	...	...	...	1	...	...	...	...	...	...	...	...
	8 Intussusception	1	.	1	...	...	...	...	...	1	...	...	...	...	...	...
	9 Strict. Intest.	1	...	1	...	...	...	...	...	...	1	...	...	...	...	...
	10 Fistula	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	11 Stomach Disease, &c.	2	4	6	...	...	...	...	1	...	...	1	2	1	1	...
	12 Pancreas Disease	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	13 Hepatitis	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	14 Jaundice	3	3	6	3	1	...	...	...	...	...	1	.	1	...	...
	15 Liver Dis. &c.	2	7	9	1	...	...	1	...	1	1	3	...	...	2	...
	16 Spleen Disease, &c.	...	1	1	...	...	...	...	...	...	...	...	...	1	...	...
	Order 5.															
	1 Nephritis	1	2	3	...	2	1	...	...	...	...	...	...	...	...	...
	2 Ischuria	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	3 Nephria	3	1	4	...	...	...	...	...	...	...	3	1	...	...	...
	4 Diabetes	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	5 Stone	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	6 Cystitis	1	...	1	...	...	...	...	...	...	...	...	...	...	1	...
	7 Kidney Disease, &c.	3	4	7	...	...	...	...	...	...	2	...	1	3	1	...
	Order 6.															
	1 Ovarian Dropsy	...	3	3	...	...	...	...	...	1	1	...	1	...	...	...
	2 Uterine Disease, &c.	...	1	1	...	...	...	...	...	...	...	1	...	...	...	...
	Order 7.															
	1 Arthritis	...	2	2	...	...	...	...	...	...	...	1	...	...	...	...
	2 Joint Disease, &c.	1	...	1	...	...	...	1	...	...	...	...	1	...	...	...
	Order 8.															
	1 Phlegmon	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	2 Ulcer	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	3. Skin Disease, &c.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Order 1.															
IV.	1 Premature Birth	14	19	33	33	...	...	...	...	...	...	...	...	...	...	...
	2 Cyanosis	1	1	2	2	...	...	...	...	...	...	...	...	...	...	...
	3 Spina Bifida	1	1	2	2	...	...	...	...	...	...	...	...	...	...	...
	4 Other Malformations	...	3	3	3	...	...	...	...	...	...	...	...	...	...	...
	5 Teething	13	9	22	20	2	...	...	...	...	...	...	...	...	...	...
	Order 2															
	1 Paramenia	...	2	2	...	...	...	...	...	...	2	...	...	...	...	...
	2 Childbirth (see Metria)	...	4	4	...	...	...	...	...	2	2	...	...	...	...	...
	Order 3.															
	1 Old Age	18	36	54	...	...	...	...	...	...	...	1	3	10	31	9
	Order 4.															
V.	1 Atrophy and Debility	31	24	55	49	5	1	...	...	...	...	...	...	...	...	...
	Order 1. (Accident or Negligence.)															
	1 Fractures, &c.	7	4	11	1	...	...	...	2	2	4	1	...	...	1	...
	2 Wounds	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	3 Burns, &c.	1	3	4	...	4	...	...	...	...	...	...	...	...	...	...
	4 Poison	1	...	1	...	...	...	...	...	...	...	...	1	...	...	...
	5 Drowning	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	6 Suffocation	8	6	14	14	...	...	...	...	...	...	...	...	...	...	...
	7 Otherwise	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...
	Order 3.															
	Homicide	...	1	1	1	...	..	..	...	...	...	...	...	...	...	...
	Order 4. (Suicide)															
	1 Wounds—Gunshot	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	" Cut, Stab	1	...	1	...	...	...	1	...	...	...	...	...	...	...	...
	2 Poison	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	3 Drowning	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4 Hanging	1	...	1	...	...	...	...	...	...	...	1	...	...	...	...
	5 Otherwise	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Cause not specified	11	13	24	9	...	1	...	1	2	1	4	5	1	...	...

TABLE IV.—Comparison of Mortality from various causes in London, and in St. Gil... Four Quarters, 1862.

Typhus and other Fevers, continued & remittent	1015	19·3	21	1046	19·8	30	848	16·1	20	863	15...

Deaths in Hospitals here included. Population of St. Giles, 1 ÷ 52·6 part of the Populatio... London in 1862.

TABLE V.—Registered Dea'hs in 52 Weeks of 1862. Sub-Districts of St. Giles's. *(Corrected, but see note to page 3†)*

Deaths in Sub-Districts. [Population 1861, corrected.]	First Quarter.		Second Quarter.		Third Quarter		Fourth Quarter.		Whole Year, 1862.		
	M.	F.	M.	F	M.	F.	M.	F.	M.	F.	Both Sexes.
St. George, Bloomsbury. [17392.]	39	46	55	44	43	50	43	22	180	162	342
St. Giles's, South. [19474.]	125	95	91	76	76	85	80	109	372	365	737
St Giles's, North. [17183.]	48	59	40	41	58	40	62	56	208	196	404
Whole District. [54049.]	212	200	186	161	177	175	185	187	760	723	1483

TABLE VI.—Registered Births in 52 Weeks of 1862. Sub-Districts of St. Giles's.

Births in Sub-Districts.	First Quarter.		Second Quarter.		Third Quarter.		Fourth Quarter.		Whole Year, 1862.		
	M.	F.	M	F.	M.	F.	M.	F.	M.	F.	Total Children
St. George, Bloomsbury ...	45	46	57	51	48	42	50	44	200	183	383
St. Giles's, South............	115	86	83	87	99	92	110	100	407	365	772
St. Giles's, North............	91	99	65	64	63	48	79	74	298	285	583
Whole District...............	251	231	205	202	210	182	239	218	905	833	1738

TABLE VII.—Houses and Population of the Ten Sub-divisions of St. Giles's. From the Census of 1861.

LOCALITY OF	INHABITED HOUSES.	RESIDENTS.
A Bedford-square	508	3948
B Russell-square	810	5551
C Coram-street	649	6104
D Bloomsbury-square	536	5251
E Church-lane	324	4674
F Dudley-street	511	9047
G Short's-gardens	384	6306
H Northern Drury-lane	370	5155
K Southern Drury-lane...	274	5057
L Lincoln's-inn-fields	308	2261
Workhouse	1	695
Total	4675	54,049

Here Eve Terrace, Old St. Pancras Road (thirteen houses and eighty-eight residents) is, for brevity's sake, included in locality A. The enumerators' returns, on which this Table is based, were kindly furnished by the Registrar-General.

APPENDIX VIII.

Regulations adopted by the Board for the future Management of Cow-houses in St. Giles's District.

1. Every Cow-house shall be on the ground level. Cow-houses under inhabited rooms, or in immediate proximity to sleeping-rooms, cannot be permitted.

2. Every Cow-house shall give to each cow a space 12 × 6 superficial feet, exclusive of gangway and channel. The cubic space for each cow shall in no case be less than 1300 cubic feet.

3. Every Cow-house shall be well lighted, and well ventilated, both in summer and winter.

4. The paving must be uniform, and the channels behind the cows must be of Yorkshire stone or of sound brick-work in cement, of the width of 2 feet 6 inches, at the least, sloping towards the entrance of the drain.

5. Dung pits shall be constructed of York stone sides and bottoms, set and jointed in cement, and shall be provided with proper drains. Dung shall be removed from the premises, where there are upwards of 10 cows, daily; where there are less than 10 cows, every second day; and always before 8 o'clock in the morning.

6. The Sheds shall be swept and thoroughly cleansed at least twice a day, and the yard once a day. Every part of the cow-houses and yard shall be lime-whited twice in the year.

7. Every Cow-house and yard shall be provided with underground pipe drains to the public sewer, furnished with efficient traps at their entrances.

8. Every Cow-house shall be supplied with water at the highest part of the channel in each shed.

9. There shall be two covered pits or receptacles, properly drained, for the stowage of grains; or if there be one pit, it shall be divided by a partition, and each part shall be properly drained. Grains and other food shall not be kept so as to become offensive.

ON

THE NATURAL CONSTANTS

OF THE

HEALTHY URINE OF MAN.

[CONCLUDED.]

BY

REV. SAMUEL HAUGHTON, M.A., F.R.S.,

FELLOW OF TRINITY COLLEGE, DUBLIN,

AND OF THE KING AND QUEEN'S COLLEGE OF PHYSICIANS IN IRELAND.

[From the Dublin Quarterly Journal of Medical Science, November, 1862.]

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JOHN FALCONER, 53, UPPER SACKVILLE-STREET,
Printer to Her Majesty's Stationery Office.
1862.

ON

THE NATURAL CONSTANTS

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PART V.—*The Daily Discharge of Sulphuric Acid in Healthy Urine of Man.*

ALTHOUGH I cannot believe that sulphuric acid and chlorine possess a value at all comparable with that of urea, in the excretions of the human body, yet it is necessary to estimate their amount in order to complete my account of the Natural Constants of Human Urine. I strongly suspect that sulphuric acid discharged in urine is the measure of the alum we eat in our bread, rather than of the excretion of the sulphur tissues of the body; and I am quite certain that the chlorine is the measure of the salt we eat with our food; and, consequently, I can attach only a secondary importance to the amount of such substances excreted. I have, however, endeavoured to determine their amount, with as near an approach to accuracy as is possible in such an investigation.

I divide my subjects, as before, into Well-fed and Vegetarian, with the following results :—

TABLE N.—*Discharge of Sulphuric Acid per day (Beef-eaters).*

No.	Sulphuric Acid—SO_3	Body Weight
1	41·85 grs.	126 lbs.
5	34·20 grs.	189 lbs.
6	40·75 grs.	145 lbs.
Mean	**38·93** grs.	**153** lbs.

TABLE O.—*Discharge of Sulphuric Acid per day (Vegetarians).*

No.	Sulphuric Acid	Body Weight
2	40·65 grs.	132 lbs.
3	18·88 grs.	146 lbs.
4	23·50 grs.	146 lbs.
5	21·00 grs.	132 lbs.
Mean	**26·01** grs.	**139** lbs.

From both these tables it appears that there is no proportionate relation between the weight of the body and the excretion of sulphuric acid.

The numbers refer to the same persons as those whose excretions were described in the former parts of this paper.

The total mean discharge of sulphuric acid, taking both tables into account, is **31·55** grs. per day, or at the rate of **0·214** grs. per day per pound of body-weight.

PART VI.—*The Daily Discharge of Chlorine in the Healthy Urine of Man.*

The following tables contain the results of my observations on the discharge of chlorine:—

TABLE P.—*Discharge of Chlorine per day (Beef-eaters).*

No.	Chlorine	Body Weight
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2	49·52 grs.	126 lbs.
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4	40·00 grs.	174 lbs.
5	79·20 grs.	189 lbs.
6	36·08 grs.	145 lbs.
1 bis.*	77·63 grs.	126 lbs.
5 bis.*	99·67 grs.	189 lbs.
6 bis.*	133·05 grs.	145 lbs.
Mean	**61·57** grs.	**149·5** lbs.

The analyses marked (*) were made by weighing the chloride of silver formed by adding nitrate of silver to an acid solution of the urine; and give results much greater than those obtained by Liebig's volumetrical process, which was employed in the earlier experiments. The mean of the results found by the more accurate method of weighing is **103·45** grs. of chlorine per day. The total mean of these, and of Table Q, is **106·56** grs. per day. I have adopted this result in Table T. The corresponding mean per day per pound of body-weight is **0·673** grs.

A comparison of the quantities of chlorine discharged by the same persons, on different days, shows how completely it depends upon accidental circumstances, such as eating salt meat or fresh meat.

TABLE Q.—*Discharge of Chlorine per day (Vegetarians).*

No.	Chlorine	Body Weight
1	115·90 grs.	173 lbs.

The general mean discharge of chlorine, taking both these tables into account, is found to be **67·00** grs. per day; or (since the average weight of body is 151·9 lbs.) at the rate of 0·452 grs. per day per pound.

Part VII.—*The Daily Discharge of Extractives in the Healthy Urine of Man.*

Under the term extractives are included all the organic compounds of the urine, not urea or uric and hippuric acids; their amount is readily found by subtracting from the total solids of the daily urine, the quantities already determined, with the bases added to the acids. If we know, for each specimen of urine, its urea, uric acid, fixed salts, and total solids, we can find the extractives by subtracting the sum of the first three from the fourth.

In this manner the following tables have been constructed:—

Table R.—*Fixed Salts and Extractives Discharged per day by Beef-eaters.*

No.	Fixed Salts	Extractives, &c., &c.	Weight
1	238·00 grs.	113·14 grs.	126 lbs.
2	244·62 grs.	131·94 grs.	126 lbs.
3	234·00 grs.	118·89 grs.	126 lbs.
4	160·00 grs.	96·60 grs.	174 lbs.
5	405·00 grs.	289·91 grs.	189 lbs.
6	297·25 grs.	268·99 grs.	145 lbs.
Mean	**263·14** grs.	**169·91** grs.	**147·7** lbs.

Table S.—*Fixed Salts and Extractives Discharged per day by Vegetarians.*

No.	Fixed Salts	Extractives, &c., &c.	Weight
1	384·30 grs.	260·60 grs.	173 lbs.
2	421·20 grs.	236·15 grs.	132 lbs.
3	261·00 grs.	134·81 grs.	146 lbs.
4	249·20 grs.	99·28 grs.	146 lbs.
5	252·30 grs.	177·71 grs.	146 lbs.
Mean	**313·60** grs.	**181 71** grs.	**148·6** lbs.

From the preceding tables it appears that the general average of fixed salts per day is **286·08** grs.; or, at the rate of 1·932 grs. per day per pound of body-weight.

And the discharge of extractives is **175·27** grs. per day; or, at the rate of 1·183 grs. per day per pound of body-weight.

If we now collect together into one table the general average of all the results obtained in the course of this investigation, we find the following:—

Table T.—*Natural Daily Constants of the Urine of the Average Man, including both Beef-eaters and Vegetarians.*

Excretion	Per Day	Per Day per Pound
Urine, . . .	52·62 oz.	2·84 drachms.
1. Urea, . . .	493·19 grs.	3·331 grs.
2. Uric Acid, . .	3·15 grs.	0·021 grs.
3. Phosphoric Acid, .	32·36 grs.	0·218 grs.
4. Sulphuric Acid, .	31·55 grs.	0·214 grs.
5. Chlorine, . .	106·56 grs.	0·673 grs.
6. Extractives, . .	175·27 grs.	1·183 grs.
7. Balance (viz., inorganic bases),	115·73 grs.	0·827 grs.
Total Solids, . .	957·81 grs.	6·467 grs. per lb.

In all the preceding investigations I required the subjects of them to live according to their usual mode, without any deviation from the regular habits of daily life, for a period of from five to seven days before that on which I estimated the constants of their urine. In this way I believe that I have succeeded in obtaining results, the accuracy of which is superior to that of those found by preceding observers. The following summary will show the method of analysis employed.

I. *Urea.*—This was determined by Liebig's volumetrical process, the test solution of nitrate of mercury being estimated by a known weight of pure urea previously prepared.

II. *Uric Acid.*—This, as well as hippuric acid, was found by weighing directly—the decomposing acid being muriatic.

III. *Phosphoric Acid.*—This was always ascertained by direct weighing, as pyrophosphate of magnesia.

IV. *Sulphuric Acid.*—This was also found by direct weighing of the sulphate of barytes formed.

V. *Chlorine.*—I regret much, that in my earlier experiments, I was induced, in estimating chlorine, to employ Liebig's volumetrical process, with nitrate of mercury, which I have not found to be trustworthy. Before I discovered my error several of my subjects of experiment had gone beyond my reach. I have endeavoured, however, to correct my first estimates in the case of three subjects, by direct weighing of the chloride of silver.

VI. *Extractives.*—These were found by subtracting the sum of the urea, uric acid, and fixed salts, from the total solids of the daily urine.

VII. *Total Solids.*—These were estimated by drying a known bulk of urine at 212° F., and weighing the residuum. The results obtained fully justify the future employment of Dr. Golding Bird's formula.

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I venture to offer the final result of my long investigation, in Table T, as a close approximation to the Constants of Daily Urine in a Healthy Man.

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I.—*Oatmeal Broth.*

The oatmeal broth of the Meath Hospital is made by the "rule of the eye and hand;" but a careful weighing of the quantities used, made for me by Mr. A. W. Foot, on several occasions, has led to the following formula:—

"Each quart of the oatmeal broth corresponds to 3 oz. 5 drms. of oatmeal, and a quarter of a pound of beef without bone."

The oatmeal is served to the patients with the broth, but the meat is generally witheld, in mercy to the digestive powers of the patient. Those, however, whose stomachs are in sufficiently good tone to digest well, have discovered the value of the beef as an addition to the broth, and have, in fact, practically made the analysis here detailed, the result of which shows that a quart of the broth possesses less urea-producing power than a quart of porter or a pound of boiled cabbage.[a] I found that 10·5 oz. fl. of broth weighed 4566 grs.; and that, when evaporated to dryness at 212° F., it left a residuum of 238·8 grs., of which, 50 grs. burned with soda-lime gave me 8·14 grs. of platinum.

Hence I find:—

	1 qt. broth.
1	40 oz. fl. broth.
105	2388 grs. @ 212° F.
5000	814 grs. platinum.
7	1 gr. nitrogen.
28	60 grs. urea.

45·33 grs. urea.

II.—*Beef Tea.*

The beef tea of the Meath Hospital is made on the liberal scale of one pound of beef, without bone, to the quart.

Of this tea, 8½ oz. fl. weighed 3694 grs.; and, when evaporated at 212° F., left of solid matter 69·6 grs., of which, 69 grs. burned with soda-lime gave 39·04 grs. of platinum.

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This is almost exactly the same value as that found for a quart of Guinness's XX Porter, and for a pound of cabbage or cauliflower boiled; while it is only one half the value of a quart of Dublin milk, and less than one-third of the value of a quart of milk taken from the cow.

Dr E. A. Parkes,
[illegible]
Rochester.

DUBLIN
JA 21
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Hence I find:—

1 qt. broth.
1 — 40 oz. fl. broth.
105 — 2388 grs. @ 212° F.
5000 — 814 grs. platinum.
7 — 1 gr. nitrogen.
28 — 60 grs. urea.

45·33 grs. urea.

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The beef tea of the Meath Hospital is made on the liberal scale of one pound of beef, without bone, to the quart.

Of this tea, $8\frac{1}{2}$ oz. fl. weighed 3694 grs.; and, when evaporated at 212° F., left of solid matter 69·6 grs., of which, 69 grs. burned with soda-lime gave 39·04 grs. of platinum.

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Der

Versuchsbau und der Sonnenbrenner

im

k. k. Garnisonsspitale Nr. 1 in Wien,

nebst allgemeinen Bemerkungen

über

Ventilation, Heizung und Dr. Heger's neuen Ventilator.

Von

Dr. C. Böhm

k. k. Regimentsarzt, Docent an der k. k. med. chirurg. Josefs-Akademie
und an der Hochschule zu Wien, Operateur etc.

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k. k. Hofbuchhändler.

Die Militärspitäler eines Staates werden im Allgemeinen nach einheitlichen Bestimmungen erbaut und eingerichtet. Die Normalien, welche bei uns zu diesem Behufe geschaffen wurden, gehören einer früheren Epoche an und entsprechen, ungeachtet der im Laufe der Zeit gemachten Verbesserungen und Einführungen, nicht mehr den Forderungen der vorgeschrittenen Wissenschaft. Diese Thatsache wird von den Aerzten tief empfunden, und es wurde von denselben im Allgemeinen und von den hiezu vermöge ihrer dienstlichen Stellung berufenen Sanitäts-Organen insbesondere nicht verabsäumt, im Interesse des Staates und der Armee eine zeitgemässe Reform anzustreben.

In Folge mancher glücklichen Bestrebungen dieser Art wurde vor zwei Jahren von dem h. Kriegsministerium eine gemischte Commission mit der Aufgabe betraut, Vorschläge über Bau, Lüftung, Heizung und Einrichtung von Militärspitälern zu berathen und zu machen, und als diese ihre Aufgabe gelöst hatte, erhielt ein aus Mitgliedern dieser Commission bestehendes Comité den Auftrag, die wichtigsten und in einem bestehenden Baue applicablen Anträge in einem Theile des hiesigen Garnisonsspitales Nr. 1 auszuführen und gründlich zu prüfen[1]).

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[1]) Im Frühjahre 1859 wurde von dem damaligen Armee-Obercommando die erwähnte Commission, bestehend aus dem Herrn Generalmajor Jacobs Ritter von Kantstein als Präses und den Mitgliedern: Oberst v. Scheibenhof, Mayer, Oberstlieutenant Baron Ebner, den Oberstabsärzten Dr. Hoffmann, Siegl, Russheim, dem Regimentsarzte Dr. Böhm und dem Kriegscommissär Market einberufen. Das Resultat der Arbeiten dieser Commission war ein mit Benützung aller Fortschritte auf dem Gebiete der Heilwissenschaft und Technik, sowie mit Berücksichtigung der ausgedehnten und werthvollen Erfahrungen, welche die Herren: Oberstabsarzt Dr. Siegl und Regimentsarzt Dr Böhm auf ihren, in dienstlicher Mission unternommenen Reisen im Auslande gesammelt hatten, ausgearbeitetes, umfassendes Programm in Form eines Protokolls. Das Kriegsministerium billigte nach sorgfältiger Prüfung sämmtliche Anträge der Commission im Princip, und ordnete an, dass die wichtigsten derselben durch genaue in grösserem Massstabe ausgeführte Versuche zu constatiren seien. Mit der Durchführung dieser Aufgabe wurden unter dem eben genannten Präsidenten, später unter dem Vorsitze des Herrn FML. Khautz von Eulenthal die Herren: Oberstabsarzt Dr. Siegl, Oberstlieutenant Baron Ebner und Regimentsarzt Dr. Böhm unter Zuziehung des Genie-Directors Herrn Major

Die Hälfte des mit der Fuhrmannsgasse parallel verlaufenden Tractes des Garnisonsspitales wurde — weil am meisten hiezu geeignet — zu diesem „Versuchsbau“ ausgewählt und durch mit Thüren versehene Abschlussmauern an den Gängen von dem übrigen Gebäude isolirt.

Der Versuchsbau besteht, wie das übrige sehr alte Gebäude, aus zwei Geschossen, welche die überflüssige — aber bereits gegebene — Höhe von 19 Fuss besitzen. Beide Geschosse sind innerhalb des Abschlusses durch eine Stiege verbunden. In jedem Geschosse befinden sich zwei Krankensäle, von welchen je einer grösser als der andere ist, und welche zusammen 96 Betten fassen. Drei von diesen Krankensälen wurden nur insoferne verändert, als das früher angebrachte, volle 9' hohe Parapet der 3 Fuss dicken Mauer mit einer einwärts gehenden Schräge versehen und so, viel an Licht, freundlichem Ansehen und an Reinlichkeit gewonnen wurde. Der vierte Krankensaal — im oberen Geschosse gelegen — wurde im Sinne des Programmes und mit Rücksicht auf die vorhandenen Dimensionen des Raumes an der Aussenwand mit grossen 10' hohen und 4' breiten Fenstern [1]) versehen, welche bewegliche jalousieartige Vorhänge einschliessen. Während die übrigen Krankensäle die gebräuchlichen und berüchtigten Fussböden aus weichen Dielen besitzen, wurde in dem letzterwähnten Saale der Fussboden aus hartem Holz und zum Theil in der gewiss zweckmässigsten Art: aus schmalen kurzen Stücken zusammengefügt [2]), bestellt. Die Betten sind bloss längs

Pilhal betraut. So entstand der Versuchsbau, dessen eigentliche Ausführung über Beschluss der Commission Dr. Böhm mit seltener Ausdauer und Aufopferung geleitet hat (Dr. Böhm ist nun auch zum Inspector der neuen Ventilations- und Heizanlagen, sowie zum Chefarzte der im Versuchsbaue errichteten neuen Abtheilung ernannt worden). Wir werden den Versuchsbau und seine Einrichtungen gelegentlich ausführlicher besprechen und würdigen, können jedoch nicht umhin, die Unternehmung schon jetzt als einen erwünschten Fortschritt auf dem bezüglichen Gebiete zu begrüssen. Oberstabsarzt Dr. Siegl hat das grosse Verdienst, die bezüglichen Fragen durch unausgesetzte Thätigkeit in dieser Richtung an die Tagesordnung gebracht und deren Lösung glücklich angebahnt zu haben, während der Präses der Commission, Generalmajor v. Jacobs, in richtiger Erkenntniss und Würdigung der Bedeutung und Tragweite des Gegenstandes die Bestrebungen der Commission, sowie das Zustandekommen des Versuches wesentlich gefördert hat, und in der angenehmen Lage war, bei seinem durch eine ihm gewordene andere Mission herbeigeführten Scheiden aus dem Comité, den Vorsitz in demselben an den, im gleichen Sinne wirkenden gegenwärtigen Präses FML. v. Khautz übergehen zu sehen. Die Redaction.

[1]) Das Programm beantragt Fenster von denselben Dimensionen für Krankenzimmer von 15 Fuss Höhe.

[2]) Ein derartiger Fussboden führt den Namen Friesboden und ist bei uns noch fast gar nicht, wohl aber in der Schweiz, Frankreich und Belgien gekannt und anerkannt. Massive Streifen aus Eichen- oder einem anderen harten Holz, 5—6 Zoll breit und bis 3—3½ Fuss lang, nicht verleimt, sondern mit Nuth und

der Pfeiler — an jedem Pfeiler zwei — angeordnet; der Fensterraum ist frei. Grössere Annehmlichkeit für die Kranken, ein geräumigeres Aussehen des Saales sind, abgesehen von der hygienischen Bedeutung, die Folge einer solchen zweckmässigen Disposition. Die Betteinrichtung ist die für Militärspitäler normirte, nur sind der Conservirung der Bettdecken und der Reinlichkeit wegen die Bettdecken mit sogenannten Spiegeln versehen. Die Einrichtung der Krankenzimmer ist die gewöhnliche, nur in dem Musterzimmer sind zweckmässiger gebaute Bettstätten und Kopfkästchen, welche zugleich als Sitz für die Kranken benützt werden können, eingestellt, und manche andere Utensilien, in zweckmässiger Weise abgeändert, eingeführt. Den Bemühungen des Herrn Oberstabsarztes Dr. Siegl ist es auch gelungen, für den Versuchsbau eine Luft-Wassermatratze von Hooper — deren Tausende im Krimkriege verwendet wurden — sowie Dr. Arnott's Wasserbett zu acquiriren. Da ich schon seit Jahren in meinen Vorlesungen zu Gunsten dieser, für manche Fälle unschätzbaren Vorrichtung, welche sonderbarer Weise auf dem Continente fast gar nicht bekannt und beachtet wurde, plaidire, so bin ich in hohem Grade erfreut, dass der Herr Oberstabsarzt Dr. Siegl, von der Vortrefflichkeit dieser Lagerungsmittel durchdrungen, die Möglichkeit geschaffen hat, dieselben auch bei uns praktisch kennen und würdigen zu lernen. Die bisher systemisirten schweren und ungefügigen Bettblenden aus Holz sind durch leichte spanische Wände und Blenden aus Eisengestänge ersetzt, und anstatt der allerdings sehr einfachen, aber unbequemen Leibstühle aus Holz sind welche aus Eisen in Form eines Lehnstuhls gebaut, eingeführt und so construirt, dass sie in der Zwischenzeit auch in letzterer Eigenschaft verwendet werden können. An der einen Stirnmauer eines jeden Krankenzimmers ist eine — in diesem Falle elektrische — Uhr mit einem transparenten, zur Nachtszeit erleuchteten Zifferblatte angebracht, sowie über Oberstlieutenant Baron

Feder untereinander verbunden, werden auf einen aus weichen, schmalen, ungehobelten Dielen bestehenden Blindboden nach Art der Parqueten genagelt. Durch verschiedene Anordnung der Holzstreifen (Friese) kann dem Fussboden eine verschiedene Zeichnung gegeben werden. Die Vortheile dieser Fussböden, welche gegenwärtig auch von der französischen Bahngesellschaft auf den Bahnhöfen in Ungarn, sowie in den neugebauten Flügeln des Administrationsgebäudes am Südbahnhofe — in eigener Regie verfertigt — in Anwendung gezogen worden sind, bestehen gegenüber den gewöhnlichen Parquetböden in grösserer Dauer und in der Zulässigkeit des Scheuerns mit Wasser. — Die Commission, überzeugt, dass diese Böden vermöge ihres Baues und der angegebenen Eigenschaften die geeignetsten, dauerhaftesten und relativ wohlfeilsten Fussböden für Krankenzimmer sind, lässt, um einen Versuch im grösseren Massstabe und mit einem richtig construirten Fussboden dieser Art durchzuführen, einen solchen Friesboden in einem Krankensaale der medizinischen Klinik der Josefs-Akademie (im Garnisonsspitale) legen.

Ebner's Antrag eine Signal- und Schall-Leitung, welche in den Maschinenraum führt, und als Vorbild einer raschen Communication — zu beliebigem Zwecke — im Allgemeinen zu dienen berufen ist. Passend angebrachte, sehr einfache, aber verglichene Psychrometer geben ununterbrochen Aufschluss über die Temperatur und den Feuchtigkeitsgehalt der Zimmerluft und regeln den Betrieb der Beheizung, sowie gewisser Massregeln bei der Ventilation. In einem der für chirurgische Fälle bestimmten Krankensäle habe ich die Leitung für kaltes und warmes Wasser so eingeführt, dass zum Behufe der Irrigation das Wasser von beliebiger und constanter Temperatur unmittelbar von der Leitung, somit unabhängig von der Aufmerksamkeit und dem guten Willen der Wärter durch einen Kautschukschlauch bis zur Wunde geführt und gleichzeitig aus dem Sammelgefässe sofort aus dem Zimmer abgeleitet werden kann. Die Krankenzimmer werden des Nachts mittelst Leuchtgas erleuchtet. Für eine gleichförmige und constante Temperatur sorgt die Centralheizung, während unabhängig von derselben die Ventilationsvorrichtung die als erforderlich erkannte bedeutende Menge frischer Luft in die Räume schafft.

Da die Einrichtungen für die genannten zwei Zwecke weiter unten näher berührt werden sollen, so genügt es hier vorläufig, zu bemerken, dass zum Behufe der Beheizung in der Mittellinie des Zimmers und um die Hälfte der Zimmerlänge etwa, von einander entfernt, in jedem Saale zwei aus zwei gekuppelten Reservoirs zusammengesetzte Wasseröfen angebracht sind, während in der Mitte des Saales das die frische Luft zuführende Ventilationsrohr $2\frac{1}{2}$ Fuss über dem Fussboden mündet und sich in den Sälen des Erdgeschosses als Säule decorirt in die Säle des oberen Geschosses fortsetzt. Eine achteckige, mit Füllungen von durchbrochenem Zinkblech versehene Verkleidung — das Piedestal der Säule resp. einen Tisch formirend — umgibt im weiteren Umfange das Ausströmungsrohr und trägt durch grössere Zertheilung des Luftstromes und Herabsetzung der Geschwindigkeit desselben dazu bei, ihn unfühlbar zu machen.

Die gegenseitige Stellung der Krankenzimmer, ihre Verbindung mit den Gängen, die Lage der Aborte war — weil gegeben — unabänderlich, obwohl sie nicht ganz dem Programm entspricht, welches auch bezüglich der Anbringung von den so wünschenswerthen und nöthigen Wärterzimmern, nicht befolgt werden konnte.

Die Gänge, deren Parapete anolog jener in den Sälen verändert worden sind, werden von der Centralheizung auf $10-12^{0}$ erheizt und entsprechend ventilirt. Zum Behufe der Beheizung sind die Gänge der ganzen Länge nach mit Heisswasserröhren durchzogen, welche längs beiden Mauern etwa 2 Zoll über dem Fussboden angeordnet sind. Da ich diese Röhre in eine entsprechend angebrachte Vertiefung der Wand

legen liess, stören dieselben weder den Anblick, noch beengen sie den Raum und sind gleichzeitig mehr geschützt. In den Fensternischen sind Bänke angebracht, welche obwohl sehr einfach, doch so construirt sind, dass beim Sitzen auch das Kreuz Unterstützung findet. Die bestandenen Vorkamine sind erweitert und in Wandschränke umgewandelt worden, eine Massregel, welche sich insbesondere der Raumersparniss wegen empfahl. Im Gange des Erdgeschosses ist ein kleiner Dampfherd aufgestellt worden, welcher sowohl zum raschen Erwärmen und Kochen von Flüssigkeiten, zur Bereitung und Warmhaltung von Cataplasmen, als auch zum Durchwärmen von Leibwäsche, Leintüchern u. dgl. verwendet werden kann. Die Wasserleitung liefert kaltes und warmes Wasser in der erforderlichen Menge in die Corridore.

Obwohl an den Versuchsbau einer der vorhandenen Aborte anstösst, so wurde dennoch und zwar innerhalb der Abschussmauer in dem Raume, welcher zwischen dem alten systemmässig hinausgebauten Aborte und dem Tracte selbst bestand, ein neuer Abort angelegt, theils um so den Versuchsbau auch in dieser Beziehung zu arrondiren, insbesondere aber, weil die gegenwärtig übliche Abortconstruction, wenn gleich sie sich bezüglich der Anordnung möglichst vieler Sitze und deren Verbindung mit der Latrine durch Einfachheit und Solidität auszeichnet, doch mit grossen Uebelständen verbunden ist, unter welchen der grösste wohl der ist, dass zu Zeiten der Abortraum und die anstossenden Gänge weithin mit Cloakengas erfüllt und verpestet werden.

Um in den Abort zu gelangen, kommt man vorerst in einen Vorraum, in welchen ein Ventilationsrohr mündet, in dem sich links ein mit Zinkblech bekleideter Abwaschtisch, so wie der zugehörige Ausguss befindet, während rechts Kästen zur temporären Aufbewahrung der Schmutzwäsche u. dgl. angebracht sind. Die Wasserleitung führt über dem Abwaschtisch das nöthige Wasser zu. In den Abort selbst — durch eine Thüre, deren untere Füllungen durchbrochen gearbeitet sind — eintretend, sieht man die von der Commission principiell ausgesprochene Trennung des Pissoirs von den Sitzen, so wie die von derselben empfohlene Construction dieser Anlagen, nach Massgabe des etwas zu karg bemessenen Raumes, ausgeführt. Das Pissoir ist nemlich mit Hinweglassung der ganz unnützen, nur Gestank erzeugenden Rinnen so ausgeführt, dass direct gegen die — im Erdgeschosse mit geglätteten Steinplatten, im oberen Geschosse versuchsweise, aber gewiss zweckmässiger und billiger, mit Cement verkleidete — Wand gepisst wird. Während diese Wand zeitweise beliebig dauernd oder mit Wasser berieselt und so vollkommen rein und geruchlos erhalten werden kann, ist der mit Asphalt bedeckte Fussboden des ganzen Abortes gegen das Pissoir — innerhalb des letzteren aber insbesondere steil — geneigt, und vermittelt so auf die einfachste Weise den raschen und völligen Abfluss etwa vergossener Flüssigkeit. In jedem Aborte sind drei Sitze angebracht, von einander durch Scheidewände getrennt und je durch eine, jedoch nicht bis auf den Boden hinabreichend, sondern etwa 8 Zoll über demselben endigende Thüre zugänglich. Die Thüre ist in einer solchen Entfernung von dem Spiegel situirt, dass wohl das Aus- und Ankleiden bequem vorgenommen, die Defäcation aber nur mit Benützung des Sitzes erfolgen kann. Zur sicheren Erreichung der letzterwähnten Absicht besteht der Spiegel aus einem blos 3 Zoll breiten wohlabgerundetem Holzringe, von welchem die Seitenwände — vorn einspringend — so schief nach Aussen abfallen, dass sie zum Stehen sich nicht eignen. Die Wasserleitung ist auch in die aus glasirtem scharf gebranntem Thon angefertigten Sitzbecken geführt, doch so angeordnet, dass Wasser blos temporär zum Behufe der leichteren und vollkommenen Reinigung mit einer gewissen Gewalt einströmen gelassen wird. — Die Centralheizung sorgt für angemessene Erwärmung der Aborte.

Um Gelegenheit zu bieten, den Erfolg der so vielfach befürworteten und auch von der Commission empfohlenen möglichst vollkommenen und raschen Trennung der flüssigen Bestandtheile der Unrathdepots von den festen, practisch kennen zu lernen, und zur Annahme dieses Systems besonders in jenen Fällen aufzumuntern, wo man auf den Gebrauch von Senkgruben angewiesen ist, habe ich eine Separationssenkgrube (Système A. Duglère) so angelegt, dass dieselbe blos die durch die Sitze herabgelangenden Flüssigkeiten zu trennen hat, indem jene, welche die Abwaschräume und Pissoirs liefern, den Séparateur nicht durchsetzen. Während so die festen Stoffe in der Grube zurückbleiben, werden die sämmtlichen Flüssigkeiten sofort in den vorhandenen Kanal abgeleitet und auf diese Art die Production übelriechender Gase in hohem Grade beschränkt. Eine einfache Vorkehrung zur Ventilation der Senkgrube, verbunden mit der Ventilation des Abortraumes, wird hoffentlich auch bei der stärksten Benützung des Locales ausreichen, dasselbe frei von belästigendem Geruche zu erhalten. Die Senkgrube ist allenthalben sorgfältig mit Cement ausgeführt und verkleidet, und gegen den Kanal durch einen Wasserabschluss abgesperrt.

Da kein Kellergeschoss vorhanden war, so musste behufs der Aufstellung der zur Ventilation, Centralheizung etc. erforderlichen Apparate, ein solches erst geschaffen werden. Zu diesem Behufe wurde senkrecht auf den Tract gegen die Fuhrmannsgasse hin ein kleiner Ausbau gemacht, welcher aus einem Keller- und einem Erdgeschosse besteht. In dem gewölbten Kellergeschosse, welches mit dem Erdgeschosse durch eine freistehende eiserne Wendeltreppe verbunden ist, befindet sich rechts der Ofen für die Centralheizung, links jener für die zwei unexplosiblen nach Perkins System construirten Dampfkesseln, in welchen die Dampferzeugung indirekt, durch überhitztes Wasser vermittelt wird. Aus dem

Maschinenraume ist ein geräumiger 5 Fuss breiter und 7 bis 12 Fuss hoher Stollen geschlagen, welcher bis unter die Mitte beider Krankensäle führt und von den den verschiedenen Zwecken dienenden Leitungen durchsetzt ist. In dem Maschinenraume ist ferner ein bei 10 Klafter tiefer Brunnen gegraben worden, aus welchem das Wasser mittelst einer doppelt wirkenden Druckpumpe in die am Dachboden aufgestellten Reservoirs befördert wird. Ein zweckmässiger Hubzähler notirt die Leistung der Pumpen. Die in dem Maschinenraume aufgestellte kleine Dampfmaschine von circa $1\frac{1}{2}$ Pferdekraft dient dem Betriebe der Ventilation — mit einem Kraftaufwand von etwa $\frac{1}{5}$ bis $\frac{1}{3}$ Pferdekraft — und bewegt zeitweise die Druckpumpe, welche für sich etwa $\frac{1}{2}$ Pferdekraft in Anspruch nimmt. — Eine Versenkgrube nimmt das vom Betriebe zeitweise in mässiger Menge herstammende Wasser auf. Das Maschinenhaus ist mit den für den Betrieb und etwaige Reparaturen erforderlichen Geräthen und Werkzeugen reichlich versehen. An dem Fensterpfeiler ist die (elektrische) Uhr und sind die Schallleitungen, so wie ein mit der Luftleitung verbundener Differentialmanometer, welcher die Geschwindigkeit und den Druck der Luft in der Leitung angibt, angebracht. Die Ventilation dieses Raumes wird in dem nöthigen Grade auf die einfachste Art mittelst der vorhandenen Temperaturdifferenzen bewerkstelligt. Während ein Kohlenmagazin ausserhalb des Maschinenhauses so angebracht ist, dass die Kohlen unmittelbar vor den Oefen in den Raum gebracht werden können, dient ein in das Freie mündender Aufzug zur Herausbeförderung der Asche, Schlacken etc., zur Herablassung des Holzes u. dgl.

Das über dem Maschinenhause gelegene Erdgeschoss des Ausbaues, in welches man aus dem Gange des Hauptgebäudes gelangen kann, enthält zwei kleine Wohnzimmer für die Maschinenwärter. Der übrige, rechts und links von dem kleinen Gange, welcher aus dem Spitalstracte in die oben erwähnten Zimmer führt, gelegene Raum dieses Geschosses, wurde, um dem Programme, welches in einem jeden Geschosse eines grösseren Krankenhauses Badezimmer vorschreibt, möglichst zu entsprechen, zu Badelocalitäten verwendet. In dem südwestlichen Theile befinden sich drei Unterabtheilungen für Wannenbäder, zu welchen man aus einem kleinen Vorraume gelangt. Die Wannen sind aus Zinkblech angefertigt, besitzen allenthalben abgerundete Kanten und sind behufs einer bequemeren Benützung sechs Zoll tief in den Fussboden des Badekämmerchens eingelassen. In einer Wannenabtheilung ist eine Douchevorrichtung angebracht. Die Erwärmung des Locales wird durch einen Wasserofen, der Abzug der Dämpfe durch den zu diesem Behufe mit einer passenden Vorrichtung versehenen anstossenden Schornstein der Centralheizung vermittelt. Der nordöstliche Theil der in Rede stehenden Geschosshälfte ist nach Massgabe des Raumes zur Herstellung eines Dampfbades — welches bisher das Garnisonsspital überhaupt nicht besass — benützt worden. Das eigentliche Dampfbad (die Schwitzkammer) enthält die üblichen Vorrichtungen zur Einströmung und verschiedenen Benützung des Dampfes, die staffelförmigen Liegebänke, so wie eine Bank zum sitzen. Die Wände des Raumes sind zum Theile von Föhrenholz, zum Theile von Mauerwerk ausgeführt und in letzterem Falle mit Cement wohl verputzt. Ich habe diesen Verputz versuchsweise mit einem wasserdichten Kalküberzug versehen, welcher, sollte er sich vollkommen bewähren, sehr geeignet zur Tünchung der Krankenzimmerwände wäre, da dieselben dann mit feuchten Tüchern gereinigt werden könnten. Für gehörige Erhellung dieses Gemaches ist durch ein entsprechend grosses Fenster gesorgt, und da durch Einführung frischer Luft und mit Hilfe des Dampfschornsteins die vorhandenen Dämpfe in kurzer Zeit beseitigt werden können, so trocknen Decke, Wände und Fussboden bald ab, was insbesondere für die längere Erhaltung der Letzteren, so wie der Thüren von Belang ist. Vor der Schwitzkammer befinden sich das Abkühlungslocale mit einer Regen- und einer kräftigen Strahldouche, welche mit Wasser von beliebiger Temperatur gespeist werden können, und das kleine Ruhekabinet, in welchem zwei mit Gurten bespannte Holzcavalete angebracht sind. Der Fussboden des gesammten Badelocales ist sorgfältig mit Asphalt überzogen und mit weghebbaren Bretern — im Schwitz- und Abkühlungslocale mit hölzernen Gittern — in solcher Höhe überdeckt, dass unterhalb die verschiedenen Leitungsröhren ungehindert hinziehen können. Der Asphaltboden ist beiderseits gegen die Mittellinie und in der Richtung derselben gegen einen Punkt, nahe der Aussenwand so geneigt, dass sämmtliche Ablaufwässer dorthin ihren raschen Lauf nehmen, um sich in den Abzugskanal zu entleeren. Obwohl diese Entleerung an einer gemeinschaftlichen Stelle stattfindet, so habe ich dieselbe dennoch so disponirt, dass die durch die Schwitzkammer kommenden, grösstentheils von der Wasserleitung aus dem Krankentracte herrührenden Gewässer, abgesondert von jenen, welche ausserhalb der Schwitzkammer herbeifliessen, in den gemeinschaftlichen Kanal gelangen. Da an dem Beginne des Canales beide Abzugsröhren in einen Wasserverschluss tauchen, so sind die bezüglichen Räume nicht nur von einander, sondern auch von dem Abzugskanale und der Aussenluft an dieser Stelle sicher und vollkommen abgesperrt. Ich habe dieses Arrangement desshalb ausführlicher besprochen, weil es auf eine einfache Weise einem grossen in Badeanstalten sehr häufig vorkommenden Uebelstande abhilft, nemlich dem, dass die Badenden durch die, aus den Wasserabzügen in die Räume gedrückte kalte oder nicht selten mit Cloakengas oder anderen übelriechenden Substanzen geschwängerte Luft unangenehm berührt und bisweilen stark belästiget

werden. Der Wasserabschluss ist allgemein bekannt, lässt sich mannigfach modificirt benützen, ist in vielen Fällen vortheilhaft anwendbar, und wird doch verhältnissmässig selten in Gebrauch gezogen.

Das für die Badeanstalt nöthige Wasser kommt gleich jenem, welches in dem übrigen Versuchsbau distribuirt wird, unmittelbar aus 2 Reservoirs, welche in einer Kammer des Dachbodenraumes aufgestellt sind, zusammen 190 Cub.-Fuss Wasser fassen, und mittelst der Druckpumpe aus dem Brunnen des Maschinenhauses gespeist werden. Während direct aus dem Dampfkessel entnommener Dampf in der Regel nur für die Schwitzkammer, und die zwei im Ausbau befindlichen Wasseröfen benutzt und nur ausnahmweise zur Erwärmung des in das Warmwasser-Reservoir überströmenden kalten Wassers verwendet wird, wird letztere für gewöhnlich — mehr als ausreichend und ökonomisch, durch den aus dem Cylinder der Dampfmaschine herausgestossenen Dampf bewerkstelligt.

Sämmtliche Lokalitäten des Versuchsbaues werden — wie schon bei den Krankenzimmern angedeutet wurde — mittelst Leuchtgas erleuchtet. Es ist dieses offenbar das zweckmässigste und relativ wohlfeilste Beleuchtungsmaterial, bezüglich dessen Benützung bei grösseren Anstalten stets nur die Frage zu beantworten ist, wie es am billigsten bezogen werden könne, ob mit Benützung bereits bestehender Erzeugungsstätten oder durch Erzeugung in eigener Regie. Da man gegenwärtig bereits sehr compendiöse ja transportable Vorrichtungen zur Erzeugung des Leuchtgases besitzt und, je nach den Lokalverhältnissen, fossile Kohle, Holz und verschiedene Materialien benützen, und die Produkte und Rückstände der Destillation selbst oder anderweitig verwerthen kann, so unterliegt es keinem Anstand, den Leuchtgasbedarf für grössere Anstalten selbst in Orten verhältnissmässig billig zu beschaffen, wo entweder die Gaspreise der Gasfabriken zu hoch gestellt sind oder keine Gasfabriken bestehen. Die Benützung des Leuchtgases — je nach Bedarf aus einer oder der andern Brennersorte gebrannt — zur Beleuchtung bewohnter Räume, insbesondere aber zur directen Erhellung der Krankensäle, erregt bei uns hie und da noch Bedenken. Diese Bedenken sind bei zweckmässig angelegter und überwachter Leitung für gut ventilirte Räume ganz ungerechtfertigt, und verlieren auch für unvollkommen oder gar nicht gelüftete Zimmer sofort an Bedeutung, wenn man sich entschliesst, so zu sagen die Flamme zu ventiliren — was in der Mehrzahl der Fälle mit keinen Schwierigkeiten verbunden ist [1]).

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[1]) Dort wo Leuchtgas zur Beleuchtung in Spitälern verwendet werden kann, gebührt — für die Erhellung der Krankenzimmer — gegenwärtig und wohl auch auf lange hin einem guten Oele unter allen übrigen Leucht-

Etwas anderes ist es, wenn es gilt grössere Räume z. B. Lese- oder Versammlungssäle, Theater u. dgl. möglichst hell und zweckmässig zu erleuchten. Da ist die allgemein übliche Anwendungsweise des Leuchtgases mit vielen Mängeln behaftet und von zahlreichen Unannehmlichkeiten gefolgt. Die grosse Anzahl in dem Locale zerstreuter oder zusammengruppirter, unstäter, flackernder Flammen, belästiget nicht nur das Auge und verdirbt — ist nicht für eine ausgiebige Ventilation gesorgt — in hohem Grade die Luft, sondern erhöht die Temperatur des Raumes in bedeutendem oft unerträglichem Masse.

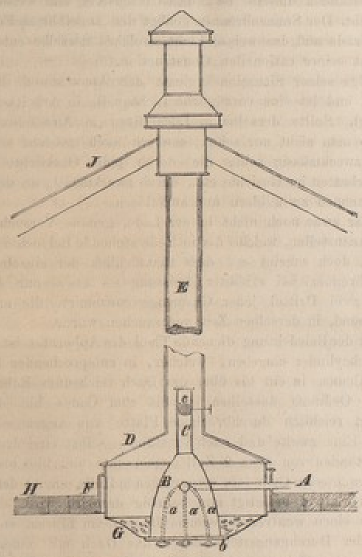
In England ist zu dem angeführten Behufe ein Apparat ziemlich verbreitet, welcher Sonnenbrenner (sunburner) genannt wird und zugleich der Beleuchtung und Ventilation dient. Ich habe denselben bei Gelegenheit meiner im Auftrage des h. Kriegsministeriums zum Studium der Ventilations- und Heizvorrichtungen unternommenen Reise kennen gelernt und war erstaunt, diese Vorrichtung weder irgendwo in Deutschland eingeführt noch beschrieben zu finden.

Die besonderen Vortheile, welche der Sonnenbrenner unter Umständen gewährt, bewogen die oben erwähnte Commission, einen solchen Sonnenbrenner im Operationssaale der chirurgischen Klinik der Josefs-Academie (im Garnisonsspitale Nr. 1) anzubringen.

Eine gleichmässige, stetige, sehr helle, das Auge in keiner Weise belästigende Beleuchtung — frei von der sonst so unangenehmen Erwärmung durch die in Anwendung stehenden Gasflammen und ver-

stoffen, deren flüchtigere Sorten allerdings zur Beleuchtung der Corridore und Höfe häufig mit Vortheil verwendet werden können, unbedingt der Vorzug. Für Krankenzimmer wird eine Beleuchtung von zweifacher Intensität benöthigt. Eine hellere — in den Abendstunden und unter aussergewöhnlichen Umständen — und eine gedämpfte — das Nachtlicht, welches die ganze Nacht hindurch nicht erlöschen soll. Während bei Benützung des Leuchtgases bekanntlich beide Zwecke mittelst desselben Brenners erreicht werden können, ist es zweckentsprechender und ökonomischer — wenn man Oel brennt — für die Abendbeleuchtung eine Argand'sche Lampe mit constantem Niveau und als Nachtlicht einen guten Schwimmer in Gebrauch zu ziehen. Alle Versuche, ohne Anwendung eines Zugglases eine längere Zeit hindurch helle und rauchlose Flamme zu erzielen, sind gescheitert und vergeblich, während Argand's Princip nur bis zu einem gewissen Dochtdurchmesser herab anwendbar und somit als Nachtlicht zu theuer ist. Die zweckmässigsten und zugleich reinlichsten Nachtlichter sind die Porzellanschwimmer von Bourrin und Oustry. Werden dieselben bezüglich der Einführung des Dochtes gehörig gehandhabt, so geben sie eine wohl kleine, aber weisse, keinen Rauch und Gestank erzeugende Flamme eine ganze Nacht hindurch. Allerdings steht das Licht, welches die Flamme Eines Schwimmers verbreitet, im Verhältniss zu dem geringen Verbrauch an Oel, allein es liegt nichts im Wege, mehrere Lampen in einem grösseren Raume zu vertheilen oder wo eine grössere Lichtintensität gewünscht wird, mehrere derartige Schwimmer in einem Lampenglase zu vereinigen.

bunden mit ausgiebiger Lüftung des Raumes, sind der Erfolg dieses einfachen, an der Decke des Saales angebrachten Apparates, ein Erfolg, der sich vollkommen nur durch den Augenschein erkennen und würdigen lässt. Diese Leistung wird durch eine sehr einfache Anordnung vermittelt, welche ich bereits einmal in der Zeitschrift des österr. Ingenieur-Vereines (1860) beschrieben habe und die ich — dem angezogenen Aufsatze folgend — kurz schildern will: Das über der Decke angebrachte Gasrohr ist an betreffender Stelle senkrecht abgebogen und geht in etwa 7 gleichfalls senkrecht hängende dünne Gasröhren über, an deren Enden horizontal befestigte runde und flache Kapseln angebracht sind,



A Gasrohr, *a* dessen Arme, die die Brenner *b* tragen.
B Conus, in die mit der Klappe *c* versehene Röhre *C* endend.
D Cylinder in das Rohr *E* übergehend.
F Cylinder als Schutzhülle.
G Verkleidung der Oeffnung des Cylinders *D*.
H Plafond.
J Dachstuhl.

welche zur Aufnahme von 5 bis 9 horizontal gestellten Fischschwanzbrennern dienen.

Diese Brenner sind von einem Conus umgeben, welcher sich oben in eine einige Fuss lange Röhre fortsetzt. Diese Röhre führt die Verbrennungsproducte sofort ab, und ist mit einer Klappe versehen, um die Luftströmung reguliren und so die grösste Intensität des Lichtes erzielen zu können.

Bekanntlich hängt die Intensität des Lichtes, ausser von dem genügenden Luftzutritt, hauptsächlich von der Temperatur ab, welche bei der Verbrennung des Leuchtstoffes erzeugt wird. Je höher unter gleichen Umständen dieselbe ist, desto intensiver und weisser ist das erzeugte Licht. Der Sonnenbrenner genügt den angeführten Forderungen in hohem Grade und das weisse Licht, welches derselbe entsendet, ist das Resultat seiner rationellen Construction.

Vermöge seiner Situation ergiesst der Apparat sein Licht von oben herab, und ist eine vorzügliche Lichtquelle in Arbeitssälen, Hörsälen u. dgl. Sollte derselbe in Localitäten in Anwendung gezogen werden, wo man nicht nur sehen, sondern auch gesehen sein will, so dürfte es zweckmässig sein, die durch jede Oberlichte erzeugten stärkeren Schatten im Gesichte etc., durch zweckmässig an den Wänden postirte Flammen zu mildern und aufzulösen.

Ich war zwar noch nicht in der Lage, genaue Versuche über die Gasmenge anzustellen, welche der in Rede stehende Beleuchtungsapparat verbraucht, doch scheint es, dass thatsächlich der einzelne Brenner im Sonnenbrenner bei erhöhter Leistung — etwa nur die Hälfte, höchstens zwei Drittel jener Gasmenge consumirt, die er für sich allein brennend, in derselben Zeit verbrauchen würde.

Dieser der Beleuchtung dienende Theil des Apparates ist von einem weiten Blechcylinder umgeben, welcher, in entsprechender Entfernung über dem Conus, in ein bis über das Dach reichendes Rohr übergeht. Die untere Oeffnung desselben ist bis zum Conus hin durch eine zierlich und reichlich durchbrochene Platte von angemessener Form verkleidet. Eine zweite und nach Umständen selbst eine dritte, jedoch nur in Abständen von etwa 2 Zoll angebrachte und blos bis zur Verengerung des grossen Cylinders emporragende Hülle umgibt den Apparat, welcher am Plafond befestigt und beliebig decorirt wird. Sollte derselbe durch einen wohlverschlossenen Bodenraum führen, so kann das Rohr an der Durchgangsstelle durch das Dach mit einem zweiten, oben und unten offenen, doch entsprechend gedeckten Rohre umgeben werden, um der Luft einen passenden Weg für ihre Bewegungen zu eröffnen.

Während die äusseren Cylinder insbesondere die Decke vor der intensiven vom Conus ausstrahlenden Hitze zu schützen und so jede

Gefahr zu beseitigen die Bestimmung haben, dient der Hauptcylinder mit seinem bis über das Dach reichenden Rohre der Ventilation. Er veranlasst einen reichlichen Austritt der Luft, während passend angebrachte Oeffnungen dem Eintritte frischer Luft dienen. Sie vermitteln zusammen ohne Belästigung einen genügenden Luftaustausch, welcher selbstverständlich, wenn gleich in geringerem Grade, auch erfolgt, wenn der Brenner nicht benützt wird.

Auf dem Gebiete der Ventilation angelangt, bin ich in der angenehmen Lage, mittheilen zu können, dass jenes System für Ventilation und Beheizung grösserer Krankenhäuser, das ich bereits in dem Plane Nr. 17 und der dazu gehörigen Denkschrift, — welche bei dem Concurse für das Krankenhaus: „die Rudolfstiftung" mit dem Preise honorirt worden sind, — entwickelt habe, nunmehr in dem „Versuchsbau" unter meiner Leitung durchgeführt worden ist.

Da ich es mir vorbehalte, nach allseitiger Prüfung der bezüglichen Einrichtungen über dieselben ausführlicher zu berichten und meine Arbeiten über Ventilation und Heizung etc. in einer umfassenden Abhandlung zu veröffentlichen, so werde ich hier nicht näher auf diesen wichtigen Gegenstand eingehen, sondern nur durch einige aphoristische Andeutungen den Standpunkt bezeichnen, welchen ich meinen Studien und Erfahrungen zu Folge auf diesem Gebiete einnehme, und zugleich die Einrichtung der betreffenden Versuchs-Anlage kurz schildern.

Die Ventilation eines Raumes kann nur durch fortgesetzte Verdünnung, d. h. Mischung mit frischer Luft erfolgen. Die älteren Anschauungen, welche darauf hinzielten, die sogenannte verdorbene Luft schichtenweise abzuführen, und in demselben Maasse durch reine Luft zu ersetzen, sind grösstentheils irrig. Eine vollkommene Ventilation erfordert somit immer bedeutende Massen frischer Luft[1]).

Die Methoden der Ventilation, d. i. die sogenannte natürliche oder die künstliche Ventilation durch Aspiration oder durch Pulsion, haben einen nur relativen Werth. Jede derselben kann unter passenden Umständen Treffliches leisten; und es hängt eben von den jeweiligen Verhältnissen ab, ob eine und welche vor der Andern den Vorzug verdiene. Wer jedoch die eine oder die andere Methode unbedingt angreift, verräth eine einseitige und daher meist unrichtige Auffassung des Gegenstandes. Es ist etwas anderes, ob ein Concertsaal, ein Theater nur im Sommer benützt wird und zu ventiliren ist oder ob dieses auch im Winter erfolgen soll, — es ist sehr verschieden, ob ein ganzes Gebäude oder nur ein Theil und welcher

[1]) S. Zeitschrift der k. k. Gesellschaft der Aerzte zu Wien, 1859, Nr. 18. „Zur Ventilationsfrage" von Dr. Böhm.

desselben zu ventiliren ist; ob die Aufgabe gestellt ist, Räume oder eine Anstalt, deren Bewohner gesund sind oder aber ein Spital zu lüften — ein Krankenzimmer oder einen Abort, ein Badezimmer zu ventiliren u. dgl.

Dort, wo — wie in manchen, speciellen Zwecken dienenden Anstalten — vollkommene Ventilation und Heizung eine unabweisliche Forderung ist, ist stets die beste — nur relativ billigste — Methode zu deren Effectuirung zu wählen und es soll der Kostenpunkt überhaupt erst in letzter Reihe in Betracht kommen. Es ist dieses ein Satz, welcher ganz allgemein — bei allen Unternehmungen giltig ist, so lange man die Zweckerfüllung im Auge hat. Nichts desto weniger wird nur zu häufig, und insbesondere auch bei den in Rede stehenden Anlagen gegen denselben verstossen.

Die Kosten des Versuchsbaues werden nicht unbedeutend sein. Es ist jedoch bei ihrer Würdigung wohl in's Auge zu fassen, dass die Gesammtkosten in der unten angegebenen Weise vertheilt werden müssen und zu berücksichtigen, dass selbst die bezüglichen Theilzahlen erst nach Verwerthung und Discussion aller näheren Verhältnisse in Rechnung gebracht und zur Beurtheilung jener Geldbeträge verwendet werden können, welche die künftige Ausführung dessen erfordern würde, was zu ermitteln und zu erproben eben die Aufgabe des Versuchsbaues ist.

Die Gesammtkosten zerfallen:

1. In die Kosten für die Ventilationsapparate.
2. „ „ „ „ „ von 1 unabhängigen Heizapparate.
3. „ „ „ „ „ Wasserleitung.
4. „ „ „ „ „ Gasbeleuchtung.
5. „ „ „ „ „ Mess-Instrumente und andere Versuchsbehelfe.
6. „ „ „ „ jene Einrichtungen, Geräthe, Werkzeuge u. dgl., die auch bei einem Neubau zu beschaffen wären.
7. „ „ „ verursacht durch die Einführung neuer Einrichtungsgegenstände und Utensilien.
8. „ „ „ für die Adaptirung eines bestehenden Gebäudes zu obigen Zwecken.
9. „ „ „ welche erwachsen sind durch — von den Commissionszwecken unabhängige — Reparatur des betreffenden Gebäudetheiles.

Bezüglich 1., 2., 3. ist zu bemerken, dass in unserem Falle auf 2. der höchste Betrag entfallen wird; dass ein grosser Unterschied zwischen den Kosten einer kleinen und jenen einer grossen Anlage besteht; dass die Kosten von Heizanlagen je nach dem Systeme, welches in Anwendung kommt, verschieden sind [1]), und dass andererseits wieder die Wahl des Systemes von dem Zwecke, von den Nebenverhältnissen, von den Anlags- und Betriebskosten abhängig ist.

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[1]) Z. B. die Anlage einer Dampfwasserheizung — der einzigen rationellen Centralheizung für ausgedehnte Gebäude — kostet bedeutend weniger als die Herstellung von Wasseröfen, welche durch Perkin's Röhren erwärmt werden, — eines Systemes, das nur tractweise angewendet werden kann —; die Anschaffungskosten meiner Oefen für constante Beheizung, sowie von Oefen überhaupt, sind im Allgemeinen geringer als die einer Centralheizung, die jedoch im Betriebe wesentliche Ersparnisse gewährt u. dgl.

Da in dem Versuchsbaue die Ventilationsanlage vollkommen und im wahren Sinne des Wortes unabhängig von der eigentlichen Beheizungsanlage ausgeführt worden ist, und sich diese Unabhängigkeit nicht blos — wie man es bisweilen aufzufassen beliebt — darauf bezieht, dass die Ventilation nicht durch die Heizapparate selbst vermittelt und somit an ihre Thätigkeit gebunden ist, so wird es möglich sein, über die Gesammt- und Einzelnwirkung beider Vorrichtungen genaue Erhebungen zu machen, die Bedeutung und das gegenseitige Verhältniss der Beheizungsvorrichtungen zur Ventilation zu bestimmen, und so diese wichtige Frage überhaupt, so wie im Sinne der möglichsten Oekonomie in den Anschaffungskosten zu entscheiden.

Wie aus dem Gesagten zu ersehen, hat der „Versuchsbau" in dieser Richtung eine grössere Tragweite und Bedeutung, als es blos jene wäre, eine rationelle, vollkommene und consequent durchgeführte Ventilation und Beheizung etc. eines Spitaltractes vor Augen zu führen.

Zur Lüftung grösserer Spitäler und Theater, sowie ohne Rücksicht auf Zweckerfüllung schon aus ökonomischen und Constructionsrücksichten, zur Lüftung aller Räumlichkeiten, wo die nöthige Luftmenge eine gewisse Ziffer erreicht, eignet sich, wie ich in mehreren Aufsätzen (Zeitschrift der k. k. Gesellschaft der Aerzte — mein Reisebericht — Zeitschrift des k. k. österr. Ingenieurvereins etc.) nachgewiesen habe, nur ein zweckmässig angelegtes Pulsionssystem. Es kann dieses System allein den strengen Forderungen der Hygiene und des Comforts, wie sie hier nothwendig gestellt werden müssen, genügen.

Die Aufgabe eines vollkommenen Ventilationssystemes ist: Eine durch die näheren Umstände bestimmte Menge — z. B. in einem Krankenzimmer 60 Cubikmeter per Kopf und Stunde — frischer reiner Luft stetig einzuführen und gleichmässig zu vertheilen; — zu sorgen: dass die Luft auf den für die Gesundheit und Annehmlichkeit erforderlichen Feuchtigkeitsgrad [1]), so wie eine entsprechende, der Zeit und dem Raume nach gleichförmige, Temperatur gebracht werden könne; — dass das Zustandekommen aller dieser Bedingungen auf eine fast ununterbrochene, jedenfalls aber die Bewohner in keiner Beziehung belästigende, somit unfühlbare Weise erfolge; — dass diese Erfordernisse auch bei Gebäuden, die aus einer Reihenfolge verschiedenartig angeordneter Räume bestehen, für jeden Raum so erfüllt werden, dass die Benützung derselben in keiner Art (z. B. durch Luftzug — festen permanenten Fensterverschluss) beeinträchtiget werde; dass dort, wo es unzulässig ist, kein — wenn auch nur zeitweises — Ueberströmen der Luft aus einem Raume in einen andern (z. B. aus Aborten in Gänge

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[1]) Diese wichtige, an sich — wie die Physik lehrt — richtige und bei jeder ausgiebigen Ventilation nöthige Massregel war und ist wohl auch jetzt noch bisweilen Ursache und Gegenstand vieler, aus irriger Auffassung des Gegenstandes entspringender, Controversen.

und Zimmer, aus einem Krankenzimmer in ein anderes etc.) erfolgen könne; dass ferner verkehrte Strömungen in etwaigen Abzugscanälen unter gewöhnlichen Verhältnissen nicht entstehen können, und in aussergewöhnlichen Fällen temporär zu Stande kommend jedenfalls unschädlich sind, und endlich dass der Gang und Zustand der Ventilation jeden Augenblick ersichtlich gemacht und controlirt werden könne.

Ein ausgedehntes, aus vielen Räumen bestehendes Gebäude kann nur dann in der ausgesprochenen Weise vollkommen künstlich ventilirt werden, wenn es an sich und insbesondere bezüglich seiner innern Anordnung für die sogenannte natürliche Ventilation — im weiteren Sinne des Wortes — *die günstigsten Verhältnisse bietet.* Dieser Forderung, welche ich, wie es scheint, zuerst klar und bestimmt ausgesprochen habe, welche ungemein wichtig — leider noch viel zu wenig erkannt und beherzigt ist — lässt sich gewöhnlich leicht genügen, wenn man deren Zweck genau kennt und jenen des Baues ernstlich anstrebt. *Bei der Bauanlage hat demnach das Ventilationssystem bereits klar vorzuschweben*[1]).

Was nun das von mir für den oben angedeuteten speziellen Fall angegebene Ventilationssystem, resp. meine Durchführung des Pulsionssystemes anbelangt, so soll dasselbe mit Rücksicht auf den eben ausgesprochenen Grundsatz die angeführte Aufgabe eines vollkommenen Ventilationssystemes lösen. Viele Ventilationsanlagen sind, wie die Erfahrung des In- und Auslandes lehrt, an der Durchführung gescheitert, haben ihren Zweck nicht oder nur zum Theil erfüllt und bisweilen

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[1]) Dieser Satz ist so einfach und verständlich, dass seine häufige Nichtbefolgung den Zustand der Ventilationsfrage in hohem Grade characterisirt. Manche Gebäude, Spitäler z. B. sind mit der besten Absicht, etwas Vollkommenes zu schaffen und mit grossem Aufwand erbaut worden. Doch da man wie z. B. in Augsburg vor und während des Baues über das einzuführende Beheizungssystem nicht im Klaren war, und sich die Frage: auf welche Art man ventiliren werde, nicht beantwortet oder vielleicht gar nicht aufgeworfen hatte, so konnte man nach Vollendung des Baues wohl noch mit Mühe eine Heisswasserheizung anlegen, aber nicht mehr eine zweckentsprechende Ventilation des schönen Gebäudes bewirken. Die in den Wänden — für alle Fälle — ausgesparten Schlotte genügten für sich nicht, zur Anordnung eines rationellen und wirksamen Systemes und das Gebäude für ein solches zu adaptiren — was bei einem Neubau keine Auslage, weil Ersparniss an Baumaterial bewirkt — war schon der hieraus resultirenden enormen Kosten wegen, unzulässig.

So die Praxis — während man allenthalben es aussprechen hört, welche Bedeutung mangelhafter Luftwechsel, mit all' seinen Folgen für die Bewohner hat; wie unerlässlich die Ventilation für Krankensäle ist und während man, bei der Erbauung von Spitälern, einen besondern Werth auf die Zweckmässigkeit der Lüftungs- und Heizungsmethode — auf dem Papiere — legt.

sogar ihrer Bestimmung so zuwider gehandelt, dass dieselben cassir werden mussten, ungeachtet sie Tausende gekostet hatten [1]). Bei dem in Rede stehenden Systeme wird dafür gesorgt, dass die nöthige Menge frischer Luft auf einem Wege in die Räume gelange, der einfach und so beschaffen ist, dass die Luft keinerlei schädliche Veränderungen erfahren könne. Die Luft wird nämlich in diesem Falle 4^0 über dem natürlichen Terrain, dessen Niveau sich etwa 4^0 über jenem der Fuhrmannsgasse sich befindet, geschöpft durch einen etwa $7\frac{1}{2}$ Klafter tiefen, mit Cement verputzten, an dem Ausbau angebauten Thurm senkrecht herabgeleitet und dann in einem sich später spaltenden Metallrohre, in welchem der Ventilator eingesetzt ist, bis unter die Mitte der Krankensäle fortgeführt, von wo sie dann senkrecht zu dem bereits beschriebenen Säulenrohre emporsteigt und so in die Säle und auf analoge Weise in die übrigen Räume — Gänge, Aborte — gelangt. Ein Zählapparat am Ventilator, der früher erwähnte Differentialmanometer und an den Mündungen des Ventilationsrohres, Indicatoren dienen zur Messung der Leistung und zur Beurtheilung des Ganges der Ventilation. *Alle verwickelten und gekünstelten Einleitungsweisen sind verwerflich und zu vermeiden.* Während in den Sälen Heizapparate — hier Wasseröfen — aufgestellt und so berechnet sind, dass sie den durch die Abkühlung der umgrenzenden Flächen entstehenden Wärmeverlust decken und unter allen Umständen zur Heizung des (nicht ventilirten) Raumes genügen, wird die Ventilationsluft im Winter bis zu einem gewissen Grade (auf oder wenig über die Zimmertemperatur) unmittelbar vor ihrem Eintritt, von einer Centralheizung aus vorgewärmt. Der so erwärmten Luft kann an derselben Stelle beliebig viel kalte Luft beigemischt und so ihre Temperatur beliebig und rasch verändert werden. Es ist jedoch zu den in der Seite 17 angedeuteten Zwecken die Anordnung so getroffen, dass die Ventilationsluft auch bis zu jenem Grade erwärmt werden kann, wo ihre Wärmemenge ausreichen würde, die Säle unabhängig von jeder andern Heizvorrichtung zu erwärmen. Für die Abfuhr der Luft sorgen passend angebrachte Oeffnungen und Canäle, da dieselben nur in wenigen Fällen — und nicht überall, wie *Pettenkofer* ausgesprochen — gänzlich überflüssig sind, sondern wichtige und häufig genug unumgänglich nöthige Bestandtheile der Anlage bilden. Die Abzugscanäle sind so bestellt, dass bei einer umgekehrten Stromrichtung, welche allerdings und auf leicht begreifliche Weise unter Umständen erfolgen kann und daher stets zu berücksichtigen ist, abermals nur reine Luft in den Raum gelangen

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[1]) Viele gute Anlagen sind aber auch in Folge unterlassener oder mangelhafter Beaufsichtigung und Unkenntniss überhaupt, zu Grunde gegangen. Dafür sind auch in Wien Belege zu beschaffen.

könne. Zu diesem Behufe habe ich schwingende Klappen — Dr. Arnott's Klappen in England genannt — in der Aussenwand und an den alten Kaminen so disponirt, dass die Zimmerluft zu denselben je nach Bedarf entweder nahe dem Fussboden oder nahe der Decke abgehend gelangen kann. Diese mit Rücksicht auf die Herabsetzung der Kosten und Erleichterung der Adaptirungsarbeit gewählte Anordnung, dürfte in ähnlichen und vielen anderen Fällen sich empfehlen und häufig genug — selbverständlich unter den geeigneten Verhältnissen — von der Führung über das Dach sich erhebender Canäle entbinden, deren Anordnung — wenn sie rationell sein und der oben gestellten Forderung entsprechen soll — mit gewissen Schwierigkeiten oder mindestens Umständlichkeiten verbunden ist. Selbstverständlich sind bei einem Neubau die Abzugsöffnungen möglichst zahlreich anzubringen, und über den ganzen Saal gleichmässig zu vertheilen.

Die ganze Anlage ist sehr einfach, übersichtlich und so gehalten, dass keinerlei Störung im Betriebe erfolgen kann. Entsprechende im Luftthurme angebrachte Vorkehrungen sorgen dafür, dass der Luft — im Winter mittelst Dampf, im Sommer durch kaltes Wasser — der aus Rücksicht für Annehmlichkeit und Salubrität wünschenswerthe Feuchtigkeitsgrad ertheilet werden könne. Bei diesem Arrangement ist sorgfältig für den sofortigen Abfluss des Wassers und so wie bei der Anordnung der ganzen Luftleitung überhaupt dafür gesorgt, dass Luft nur von der Mündung des Luftthurms, aber ja nicht irgendwo anders her in die Leitung gelangen könne.

Zur Ventilation bewohnter Räume ist die Verwendung von Centrifugalventilatoren, um deren Theorie und Construction sich der k. k. Sectionsrath Rittinger in anerkannter Weise verdient gemacht hat, nicht vortheilhaft, theils weil ihre Form von der Art ist, dass sie bei den zu fördernden grossen Luftmengen einen sehr grossen Raum einnehmen (indem die Luft nicht auf dem kürzesten Wege durch die Maschine gelangt); theils weil sie mit keinem besonders grossen Wirkungsgrade arbeiten; so wie, weil die hohen Pressionen, welche sie liefern, nicht erforderlich sind, und nur die Betriebstkosten unnöthig vermehren.

In neuerer Zeit hat man in Frankreich den sehr einfachen Schraubenventilator von Dr. Van Hecke mehrfach angewendet, und denselben zu Ventilationszwecken warm empfohlen. Da jedoch die Construction dieses Ventilators mir die Vermuthung aufdrängte, dass der gewährte Erfolg ein nur scheinbar so günstiger sei; da die Theorie der Ventilatoren, besonders jene der Schraubenventilatoren noch nicht hinreichend bearbeitet war, und da zu erwarten stand, dass ein genaueres Studium in dieser Richtung — nach den Erfolgen bei verwandten Maschinen zu urtheilen — zu einer neuen zweckmässigeren Construction

dieser Ventilatoren führen, und so nicht nur einen Gewinn für die Praxis, sondern auch für die Wissenschaft abwerfen würde, so hatte ich meinen Freund Dr. J. Heger, der als exacter Mathematiker in massgebenden Kreisen bekannt ist, bewogen, sich für diesen Gegenstand zu interessiren. Die Resultate der Untersuchungen, welche Dr. Heger zu unternehmen so gefällig war, so wie die Ergebnisse der praktischen Versuche und Messungen, welche mit dem von Dr. Heger construirten Ventilator im Auftrage der erwähnten Commission angestellt worden sind, sind von der Art, dass sie — es gewährt mir eine grosse Befriedigung, es aussprechen zu können — den gehegten Erwartungen vollkommen entsprechen.

Obgleich schon nach den ersten erfreulichen Ergebnissen dieser Untersuchung beschlossen wurde, den neuen Ventilator in dem Versuchsbau zu benützen, so wurde dennoch provisorisch ein Ventilator nach Dr. Van Hecke eingesetzt, sowohl um die Benützung der Krankenabtheilung im Versuchsbau nicht unnöthig hinauszuschieben, als auch um positive Studien bezüglich der Leistung des letzterwähnten Apparates zu machen.

Als Resumé der von Dr. Heger und mir gemeinschaftlich angestellten Versuche und Messungen lässt sich bezüglich der beiden Ventilatoren Folgendes anführen:

Ventilator von Dr. Van Hecke. Bei diesem Ventilator findet nur im peripherischen Theile des Rohres eine Strömung statt, während im centralen Theile nur Wirbel und unregelmässige, sogar eine verkehrte Richtung habende, Luftströme entstehen. In Folge der geringen Anzahl von Flügeln (2), strömt selbst in dem peripheren Theile Luft nicht continuirlich durch den ganzen Querschnitt, sondern wird nur partiell hinausgeschleudert.

Die Luft tritt nicht parallel zur Achse aus, sondern schliesst mit ihr einen bedeutend grossen Winkel ein, dessen Grösse von 45—60° variirt.

Zum Betriebe ist eine bedeutende Kraft erforderlich, was zusammengehalten mit der Pressungsdifferenz und dem geförderten Luftquantum kaum einen Wirkungsgrad über 15—18% geben dürfte. Der eingestellte Ventilator ist ausserdem unvollkommen, da er bei grosser Revolutionszahl das Luftquantum nicht geräuschlos liefert, und zur Förderung der angesprochenen Luftmenge eine Umdrehungsgeschwindigkeit erheischt, welche sowohl des Geräusches wegen, als auch im Hinblick auf die Abnützung der Lager unzulässig ist.

Herr Haag hat einer mir von mehreren Seiten zugekommenen Mittheilung zu Folge Dr. Van Hecke's Ventilator dahin abgeändert, dass er den Flügeln nicht mehr die Form eines Parallelogramms, sondern eines gleichschenkligen Dreieckes — die Basis gegen die Peripherie gewendet — gibt, und so die Luft dort, wo sie die grössere Geschwindigkeit hat, immer mit grösserer Fläche erfasst. Der so abgeänderte Ventilator soll 40—50 Proc. mehr Luft fördern, als jener von Van Hecke. — Die vermehrte Luftförderung unterliegt wohl keinem Zweifel [1], dessenungeachtet behalten mutatis mutandis die oben ausgesprochenen Sätze auch bezüglich dieses Apparates ihre Geltung.

Ventilator von Dr. Heger. Dieser Ventilator ist sowohl mit als ohne Leitcurven anwendbar.

Mit Leitcurven liefert er bei zweckmässiger Construction die austretende Luft, ohne alle Seitenablenkung, vollkommen parallel zur Achse des Rohres und in regelmässiger Strömung.

Die Bewegung muss aber eine verhältnissmässig langsame sein, wenn die Luftförderung geräuschlos erfolgen soll, eine Bedingung, der man bei Ventilationanlagen schon aus dem Grunde nachkommen muss, weil durch zu grosse Geschwindigkeiten die Hindernisse und in Folge dessen die Betriebskraft unnütz vermehrt werden würde.

Für andere Zwecke, wo es gestattet ist, eine grosse Geschwindigkeit im Leitungsrohre anzuwenden, liefert er auch höhere Pressungen wiewohl unter Summen wie alle übrigen Ventilatoren.

Der Wirkungsgrad dieses Ventilators ist weitaus grösser als der aller Bestehenden und zwar durchschnittlich 55%. Es ist dieses das ungeschminkte Resultat sehr genauer Messungen [2].

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[1] J. Haag, früher ein eifriger Verfechter des Aspirationssystems im Allgemeinen (Neues System für Heisswasserheizung und Ventilation von J. Haag, 1858, p. 26), ist durch die günstigen Erfolge aufgemuntert, nun auch Vertreter des Pulsionssystemes geworden, und hat dasselbe sofort — mit Benützung seines oben erwähnten Ventilators — zur Ventilation des eben vollendeten grossen Concertsaales in Frankfurt in Anwendung gezogen.

[2] Der Wirkungsgrad eines Ventilators ist hauptsächlich für den Kostenpunkt des Betriebes massgebend, da unter übrigens gleichen Umständen diese dem Wirkungsgrad verkehrt proportional sind, so zwar, dass ein Ventilator von 45% Wirkungsgrad nur das Drittel des Brennstoffes erfordert als die bekannten Ventilatoren, welche nur 15% geben. Die Bewegung eines Ventilators von der oben angedeuteten Construction, welcher 7000 Cubikmeter Luft per Stunde fördert, nimmt blos circa $\frac{1}{3}$ Pferdekraft in Anspruch. Da man in neuerer und neuester Zeit durch die Erfindung und Verbesserung der calorischen Maschinen, der Gasmaschinen und der elektromagnetischen Kraftmaschinen bemüht ist, gerade für so kleine Kraftbedürfnisse zweckmässige Motoren herzustellen und der vollkommene Erfolg dieser Bestrebungen kaum mehr bezweifelt werden kann, so wird in nächster Zukunft die Einführung der mechanischen Ventilation auch von dieser Seite her nicht nur wesentlich erleichtert werden, sondern es wird auch ohne Schwierigkeiten möglich sein, das Pulsionssystem strenge nach den von mir aufgestellten Grundsätzen und dabei möglichst ökonomisch anzuordnen und zu benützen, indem man — wie ich schon im Memoire des Concurs-Planes (1859) angegeben habe — mehrere, aber dafür kleinere Ventilatoren an geeigneten Orten anbringt.

Derselbe Ventilator lässt sich auch ohne Leitcurven zur Luftförderung anwenden, hört aber dann auf, eine so vollkommene Maschine zu sein, indem er die Luft unter einem grösseren oder kleineren Winkel gegen die Achse des Rohres geneigt, austreten lässt. Dadurch sinkt der Wirkungsgrad herab bis zu jener Grösse, die die übrigen Ventilatoren zweckmässiger Construction besitzen (20—25%). Die Umdrehungsanzahl muss bei gleichen Verhältnissen grösser gewählt werden, als bei Anwendung von Leitcurven. Dafür tritt aber ein anderer günstiger Umstand ein, nemlich, dass bei zweckmässiger Anordnung der übrigen Theile selbst eine grössere Umlaufsgeschwindigkeit kein merkliches Geräusch verursacht.

Diese letztere Anordnung dürfte daher bei solchen Ventilationsanlagen, wo es nicht auf einen besonders hohen Wirkungsgrad der Maschine ankommt, anzuwenden sein.

Dr. Heger's Ventilator spielt also gegenüber den bestehenden Ventilatoren und Saugpumpen dieselbe Rolle, wie die vollkommenen Turbinen von Fourneyron, Jonval etc. gegenüber den alten Stoss-(Wasser-) Rädern.

Bezüglich der Heizung will ich nur erwähnen, dass vom wissenschaftlichen und ökonomischen Standpunkte für ausgedehnte Anstalten nur eine Centralheizung, und sind solches continuirlich bewohnte Räume, insbesondere die Dampfwasserheizung berechtigt erscheint, während kleinere Gebäude oder kleinere Complexe eines ausgedehnten Baues mit Vortheil mittelst Haag's Heisswasserheizungssystems beheizt werden können, welches mit Perkin's System identisch ist, bezüglich der Ausführung aber die glückliche Mitte zwischen diesem und Duvoir's System hält und frei von ihren Uebelständen ist. Erfordern besondere Umstände auch da die Anwendung von Wasseröfen, so kann Perkin-Haag's System zweckmässig anstatt des Dampfes zur Transmission der Wärme an die Wasseröfen verwendet werden. Die erste Ausführung eines solchen Systems habe ich in dem angedeuteten Versuchsbaue veranlasst [1]. Sind jedoch die Bedingungen für die Luftheizung im engeren Sinne des Wortes (Meissner's System) vorhanden, so wird diese rationelle und billige, aber bezüglich der Ausführung schwierigste Heizanlage

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[1] Die Lieferung und Aufstellung der für die Heiz-, so wie für die Ventilationsanlage erforderlichen Apparate wurde von der Commission dem Civilingenieur und Fabrikanten Joh. Haag in Augsburg überantwortet. Um die Richtigkeit und Leistungsfähigkeit der Anordnung des Systemes prüfen und beurtheilen zu können, musste die Solidität der nöthigen Einrichtungen von vorne herein gesichert werden.

sehr gute Resultate erzielen lassen, vorausgesetzt, dass die verwendeten Oefen zweckmässig construirt sind.

Was die Oefen zur Einzelnbeheizung anbelangt, so ist man bei der jetzigen Kenntniss der hiebei in Betracht kommenden Verhältnisse *vollkommen in der Lage, derartige Heizapparate ganz zweckentsprechend zu construiren,* und besitzt in dem schon vor langen Jahren von dem würdigen Professor *Meissner* angegebenen Mantel das Mittel, selbst gewöhnliche eiserne Oefen ihrer Hauptmängel zu entkleiden und mit Vortheil zu benützen.

Wenn gleich in vielen Fällen Massenöfen besondere Vortheile gewähren und es möglich ist, aus Thon allein oder besser in Verbindung mit Eisen rationelle Heizvorrichtungen nach Art der sogenannten schwedischen Oefen zu erzeugen, so bleibt dennoch das *Eisen ein Material, welches für die meisten der bei uns in Betracht kommenden Verhältnisse sich am besten zur Construction von Oefen eignet.*

Nicht nur Mantelöfen, sondern auch frei stehende Oefen lassen sich von Eisen so construiren, dass jene Nachtheile vollkommen beseitiget sind, welche an den gewöhnlichen eisernen Oefen beobachtet, als nothwendiges Attribut der aus diesem Materiale erzeugten Heizvorrichtungen angesehen werden. Ich werde auch diesen Gegenstand seiner Zeit ausführlich zur Sprache bringen, um so mehr, als ich die Richtigkeit des Gesagten durch die von mir im Auftrage des h. Kriegsministeriums construirten Oefen nachweisen zu können in der Lage bin.

Die Zimmerbeheizung und die Ofenfrage liegt in der Praxis auch noch im Argen, obgleich — wie oben angedeutet wurde — die wissenschaftliche Pyrotechnik bereits einen Standpunkt einnimmt, welcher die volle Lösung dieses Problemes gestattet. Die Ursache dieser Erscheinung liegt zu nahe, als dass ich sie auseinandersetzen sollte.

Die Aufgabe eines Ofens zur Zimmerbeheizung ist: neben einem möglichst hohen pyrometrischen Effect nicht nur einen möglichst vollkommenen calorimetrischen Effect zu erzielen, sondern auch je nach Umständen entweder eine rasche, vorübergehende, oder aber eine dauernde gleichmässige und gleichförmig vertheilte Erwärmung — wie es für Wohn- und Krankenzimmer u. dgl. wünschenswerth oder nöthig ist — zu vermitteln. Das erstere wird durch eine den Grundsätzen der Pyrotechnik entsprechende Anordnung der Verbrennungsstätte etc., das letztere durch möglichste Ausnützung der producirten Wärmemengen mittelst der Anwendung entsprechend grosser und zweckmässig angeordneter Heizflächen erreicht. Die zweckmässigste Form dieser Heizflächen — die an sich unter übrigens gleichen Verhältnissen für den Wirkungsgrad des Ofens als Wärmequelle gleichgiltig ist — wird durch die Bestimmung des Ofens, durch die Rücksicht auf gleichmässige Wärmevertheilung und durch den Kostenpunkt

näher bestimmt. Die von mir construirten Oefen sind äusserlich mit zahlreichen Längsrippen versehen (analog dem hauptsächlich Wasserverdampfung anstrebenden Systeme *Gurney*) und innerlich je nach ihrer Bestimmung für die verschiedenen Brennstoffe, verschieden aber sehr einfach den wissenschaftlichen Grundsätzen gemäss eingerichtet. Am vollkommensten löst die oben angedeutete Aufgabe der Coaks-Ofen, der zu continuirlichem Betriebe eingerichtet, den Brennstoff möglichst vollkommen ausnutzt, eine sehr geringe Bedienung bedarf, und auf die ökonomischeste Weise Tag und Nacht u. s. f. längere Zeit hindurch eine constante und gleichförmige Temperatur zu unterhalten vermag. — Auch bei dem Steinkohlenofen genügt eine Charge auf 5—7 Stunden. Bei demselben sind jedoch der Natur der Dinge nach schon grössere Temperaturschwankungen möglich. Bei den mit Steinkohlen gespeisten Oefen ist die Rauch- und Russerzeugung auf jenen Grad beschränkt, welchen herabzusetzen bei so kleinen Feuerungen nicht mehr rationell ist. — Die Oefen sind auch eingerichtet, die von Aussen zur Ventilation an sie gelangende Luft vorzuwärmen, zu welchem Zwecke eine Klappe neben dem Ofen angebracht wird, welche so angeordnet ist, dass bei jeder Stellung derselben die zugehörigen Kanäle geöffnet, resp. geschlossen sind, welche zusammen zu wirken haben.

Es ist eine unbestreitbare Thatsache, dass für Ventilation und zweckmässige Heizung im Allgemeinen noch sehr wenig geschehen ist, und dass das Bedürfniss derselben nicht in dem Maase gewürdigt wird, wie es dieser wichtige Gegenstand verdient. Eine Wanderung durch unsere Schulen, Kanzleien, Spitäler, Gefängnisse — der Besuch von Versammlungssälen, Theatern, Kaffeehäusern, die Betrachtung der Wohnungen der ärmeren Classe, ja der Wohnungen im Allgemeinen liefern nur zu viele Beweise für die Richtigkeit des obigen Ausspruches.

Eine rationelle zweckmässig ausgeführte Ventilationsanlage sieht sehr einfach aus; sie ist es auch in der That, doch erfordert ihr Entwurf grosse Umsicht, ihre Ausführung strenge Genauigkeit, soll der Zweck thatsächlich vollkommen und nicht blos scheinbar oder nur zum Theil erfüllt werden. Das nicht seltene Misslingen solcher Anlagen ist Ursache, dass man sich bis auf die neueste Zeit vielfach darin gefallen hat, das Problem der Ventilation grosser Gebäude als ungelöst hinzustellen und namentlich die Methoden der künstlichen Ventilation als ungenügende, kostspielige Versuche zu erklären. War ein solcher Ausspruch vor wenigen Jahren noch berechtigt, so ist er es gegenwärtig nicht mehr. Das Ventilationsproblem ist gegenwärtig vollkommen zu lösen und es hängt das völlige Gelingen in der Praxis nur mehr von der richtigen Wahl und der rationellen Ausführung eines Systems ab. Eine derartige Wahl und Ausführung setzt aber ein vollkommenes Verständniss des Problems und der Methoden der Ventilation, so wie die Kenntniss der hier in Betracht kommenden ziemlich complicirten Verhältnisse voraus, also eine Fachkenntniss, welche sich nur aus ernsten Studien und Arbeiten auf diesem Gebiete herausbildet. Aber ausser der Fachkenntniss wird noch eine strenge Ueberwachung der praktischen Ausführung erfordert, um derartige Anlagen zu schaffen, welche den Forderungen und Grundsätzen der Wissenschaft, sowohl bezüglich der Vollkommenheit als relativen Wohlfeilheit der Leistung entsprechen.

Die oben angedeuteten bezüglichen Bedürfnisse, so wie die zu überwältigenden Schwierigkeiten sind jedoch zur Zeit selbst von Ingenieuren und

Technikern [1]) zu wenig, geschweige denn von Laien gekannt. Nur so sind die Verstösse erklärbar, die man in der Praxis so häufig begangen findet, nur so die Urtheile und Anschauungen zu entschuldigen, die man aussprechen hört [2]).

Es würde mich zu weit führen, wollte ich an dieser Stelle diese Verhältnisse näher betrachten und die Momente ausführlicher würdigen,

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[1]) In den Lehrbüchern der Baukunst z. B. sieht man vergebens nach einer gründlichen Behandlung des Capitels über die Ventilation und Heizung, und doch sind es die Architekten und Baukünstler überhaupt, welche, da sie die Anlage zu Bauten entwerfen und ausführen, zunächst berufen wären, in dieser Beziehung zu wirken und die bessere Einsicht zu verbreiten. Die Bauvorschriften sollen nach dem Beispiele Englands bestimmte Anordnungen über Ventilation enthalten. — Leider siecht unsere Bauordnung noch an vielen anderen hygienischen Mängeln und ich erlaube mir auf den Wortlaut der Petition hinzuweisen, welche die k. k. Gesellschaft der Aerzte im Interesse der Humanität und Wissenschaft an das h. Staatsministerium zu richten sich bewogen befand. (S. Zeitschrift der Gesellschaft. 1861. Nr. 21.) Würden Regierung und Schule sich die Hand reichen, dann wäre bald die nöthige Aufklärung des Publikums vermittelt, und die Salubrität von Privat- und öffentlichen Wohnungen und Etablissements durch die Sorge für eine entsprechende Beschaffenheit des nöthigsten Lebenselementes — der Luft — auf jenen Standpunct gebracht, wie ihn die Humanität und der Comfort fordert und die Wissenschaft auf eine billige Weise vermittelt.

[2]) Bezüglich des Gesagten sind die folgenden Worte Péclet's (siehe Nouveaux documents relatifs au chauffage et à la ventilation, 1853, p. 95) der Beachtung werth:

On comprend tous les jours davantage la nécessité du chauffage et de l'assainissement des habitations particulières et des édifices publics. Aussi, depuis quelques années, un grand nombre d'édifices publics ont été chauffés et ventilés; mais l'industrie du chauffage et de la ventilation fait réellement peu de progrès. Les causes en sont nombreuses: Les phénomènes généraux qui se produisent dans le chauffage et la ventilation paraissent fort simples, car ils se reduisent à la transmission de la chaleur à travers les corps, et aux mouvements de l'air produit par la chaleur ou des machines, qui ne reposent que sur les lois les plus élementaires de la physique et de la mecanique. Il semble, que les seules choses difficiles, mais qui sont entierement du ressort des ingénieurs, consistent dans les dispositions, dans la determination des formes et des dimensions des appareils destinés à produire un effet donné, et enfin, dans les moyens de régulariser le chauffage et la ventilation. Mais les choses ne sont pas aussi simples quelles le paraissent au premier abord, et pour juger un projet ou un appareil fonctionnant, des notions générales ne suffisent pas, il faut avoir étudié sérieusement les questions qui s'y rapportent. Aussi on ne rencontre souvent, chez les personnes qui sont appelées à donner leur avis sur des projects ou des appareils construits, que des idées vagues, incomplètes et même parfois erronées. Quelquefois les projets de chauffage et de ventilation sont mis au concours; mais le plus souvent les travaux sont concédés directement à des entrepreneurs favorisés. Par ce dernier mode de concession, on supprime la concurrence, et par suite on arrête tout progrès, toute amélioration

welche denselben zu Grunde liegen. Schrift und Wort kann dieselben nur auf dem sehr langsamen Wege der Belehrung und Anregung zu beseitigen streben, während die gelungene That allein dadurch einer Sache Bahn zu brechen vermag, dass sie die practischen Consequenzen deutlich erkennen lässt, unmittlelbare Vergleiche zulässt und ein Argument bildet, das durch Sophismen nicht mehr umgestossen werden kann. Der weise Entschluss des h. Kriegsministerium's umfassende Erhebungen und Versuche über diese wichtigen Gegenstände anstellen zu lassen, kann an sich und insbesondere auch in Anbetracht der bevorstehenden grösseren Bauten in Wien nicht hoch genug veranschlagt werden und es dürfte nicht unpassend gewesen sein, auf die nächsten Folgen desselben aufmerksam gemacht zu haben.

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dans la disposition des appareils, toute économie dans les dépens premières et dans les frais journaliers. Enfin, une derniere circonstance qui a une très grande influence sur la lenteur des progrès de l'industrie dont il est question, c'est la manière dont se font les experiences de réception, quand toutefois il s'en fait. On se contente souvent, de quelques experiences sur la ventilation totale, pour lesquelles tout avait été disposé, mais qui ne donnent aucune garantie, que l'appareil a une puissance suffisante pour les circonstances atmosphériques les plus défavorables, que le chauffeur a un moyen assuré pour diriger son foyer de manière à obtenir toujours le même effet, que cet effet est toujours realisé, que toute la ventilation est réellement efficace pour l'assainissement, et enfin, que la ventilation est uniformément repartie, dans l'espace occupé. Des experiences sur la ventilation totale, un certain jour, à une certaine heure, sans aucun autre renseignement, comme cela arrive le plus souvent, ne prouvent réellement que le fait même qu'elles constatent, et ne peuvent servir qu'à induire en erreur les personnes qui ne comprennent pas combien elles sont insuffisantes pour porter un jugement sur l'appareil.

Il serait bien à désirer qu'à l'avenir: 1. la construction des appareils de chauffage et de ventilation des édifices publics, ne fût accordée à un constructeur, qu'à la suite d'un concours devant une commission composée de personnes competents; 2. que les rouages administratifs qui séparent la décision de la commission de l'exécution, fussent simplifiés, et surtout que cette décision eût plus d'autorité que par le passé; 3. que l'examen des appareils, après leur construction, fût prolongé pendant un temps suffisant, pour constater la puissance des appareils de chauffage dans les circonstances les plus défavorables, celles des appareils de ventilation, la régularité de la ventilation totale, l'uniformité de sa distribution, l'exactitude des instruments destinés à indiquer à chaque instant l'état de la ventilation, les consomations de combustible etc.; 4. que les rapports de ces deux commissions fussent publiés.

Ces mesures rassureraient complétement les administrations sur les effets des appareils, et l'industrie du chauffage et de la ventilation ferait de rapides progrès. Les ingenieurs capables ne pourraient qu'y gagner, car il n'y a point de secrets dans les appareils de chauffage, les expériences profiteraient à tous, et les inventions de chacun, protégées par des brevets, seraient parfaitement respectées.

Mein besonderer Beruf rückt mir zwar das Gebiet der Ventilation und Heizung, welchem ich seit Jahren eine besondere Aufmerksamkeit zugewendet hatte, nach Beendigung meiner bezüglichen Arbeiten, in constructiver Beziehung wieder fern, nichts desto weniger bin ich im Interesse einer guten Sache und mit Rücksicht darauf, dass ich als Arzt von der Wichtigkeit und Tragweite des in Rede stehenden Gegenstandes durchdrungen bin, und durch Verhältnisse in der Lage war, mir besondere Fachkenntnisse in diesem Gebiete zu erwerben, gerne bereit, zur Förderung aller bezüglichen Bestrebungen nach Kräften durch Rath und That beizutragen.

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ON THE INVESTIGATION

OF

INSTINCTIVE MOVEMENTS.

BY WILLIAM MURRAY, M.D.

Demonstrator of Anatomy in the College of Medicine, Newcastle-upon-Tyne, and Physician to the Newcastle Dispensary.

Read before the Physiological Section of the British Association assembled at Newcastle-on-Tyne, August, 1863.

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OF

INSTINCTIVE MOVEMENTS.

THE following remarks are intended to be an analysis of the various movements termed INSTINCTIVE, assigning to each its origin in the nervous system, and thus demonstrating the part which each of the sources of nervous power plays in generating motorial effects, which, in their aggregate, make up an instinctive act or set of actions. It will be seen, that in this way we are studying instinct on physiological principles, avoiding the metaphysical side of the question; and in doing so, we propose to pursue the eliminating method of scientific research. For instance, we are about to analyse an instinctive act, how shall we do so? To define and attribute it to an unknown power working in an animal as an automaton, is but to render more intricate the difficulties which already exist; but to select from it all that is due to reflex action, to eliminate still further that which is emotional, and thus to subtract the known from the unknown, is by all means to simplify. As we progress in our investigation of an act, of course the known becomes greater and the unknown less, till at last it has no existence. I would, before entering on my investigation, remark how exceedingly useful the eliminating method has been in simplifying the science of physiology. As long as LIFE was looked upon as an entity, and men spent their time in defining it as a whole, this idea of it presented a shield to prevent its investigation, against the thick bosses of which it was vain for the mightiest intellects to rush. But as soon as the analytical method was commenced, and men began to eliminate all they *knew* to be physical, mechanical, or chemical, from that which they *thought* to be vital, the unknown became wonderfully less, till now, in the minds of those who hold life to be the result of physical and chemical forces only, the vital force has no existence. Of this we are certain, that we are daily finding life to be due more to the chemical and other known forces, and less to the vital force; and as this latter stands for the unknown quantity in our physiological equation, we must all admire the process by which it is losing its extent of prerogative, and parting with the secrets which we, in our ignorance, have attributed to it. In analysing the various movements of which we are conscious in our persons, and in comparing these with similar and allied movements in the lower animals, we must conclude that they are all due to one of *three kinds* of nervous force (the volitional or voluntary—the emotional, which is due to feeling, and the reflex), and that they are seldom due to any one of these acting alone. Seeing, then, that our acts are thus the result of one, two, or more kinds of nervous agency, may we not fairly inquire whether the instinctive movements of the lower animals be not due to the same agencies acting in an exalted degree? whether it may not be, that just as our volitional power is vastly superior to either our reflex or emotional power, so, in the lower animals, these latter acquire other and more wonderful properties than we see them to possess in our own persons? But it may be asked, what are these sources of nervous power, and how do they thus combine to produce the acts of which we speak? We can, I think broadly class all movements in our persons into the three above-mentioned varieties.

Those which are voluntary........................	THE VOLITIONAL.
Those which are the result of feeling, or emotion..................................	....THE EMOTIONAL.
Those which are the result of a physical stimulus, applied to or conveyed to a nervous centre, and reflected by it along a motor nerve, to call forth a movement	........THE REFLEX

As we shall presently show, we cannot class movements thus otherwise than broadly; for if we scrutinize them, we shall find by far the larger number composed f two or more of these three original and simple varieties. We therefore classify our movements thus. Those which are SIMPLE or ELEMENTARY—

THE SIMPLE..............................	THE VOLITIONAL. THE EMOTIONAL. THE REFLEX.

Those which are composed of two or more of these—

THE COMPOUND.	THE VOLITIONO-REFLEX. THE VOLITIONO-EMOTIONAL. THE EMOTIONO-REFLEX. THE VOLITIONO-EMOTIONO-REFLEX.

I shall now proceed to give examples of each of these movements, making bold to affirm that they include every movement in the human body, and I hope therefrom to show that they make up the instinctive movements of the lower animals.

1. As an example of a simple volitional movement, we have—a prehensile movement, when performed apart from emotion.

2. As examples of emotional movement—LAUGHING or CRYING, when involuntary and irresistible.

3. As examples of simple reflex movements—those of respiration and the beating of the heart during sleep.

It will at once appear that any of these simple movements may at any moment become compound by uniting with one of the others.

The prehensile movements, under the stimulus of desire or fear, become emotiono-volitional; and the reflex action of the heart or lungs is easily excited to greater activity by emotion, converting it into an emotiono-reflex act. These remarks lead me to the consideration of the *compound movements*, a subject much more intricate, but capable of being wonderfully simplified, and in its extent comprising almost all, if not all, the instinctive movements of the lower animals.

COMPOUND MOVEMENTS.

THE VOLITIONO-REFLEX.

Here we have an interesting example of the manner in which the nervous forces act and re-act upon each other with the most exquisite response.

The act of swallowing, under ordinary circumstances, is a volitiono-reflex movement. Try to perform it with an empty pharynx, and you at once feel your need of the reflex part of the act. A morsel of food, however, is sufficient to excite the reflex part of the act, and now the difficulty is not to produce but to restrain the act by volition. Movements of this variety, aided or restrained by volition, are very common. Such are—

1. Vomiting, aided or restrained by the will.
2. The act of micturition, of defecation, &c.

VOLITIONO-EMOTIONAL.

In many acts performed by us, reflex action plays no part, and yet they are compound—the Volitiono-Emotional. I wish to perform an act, a strong motive connects itself therewith, and I acquire a power to do it which mere volition could never have afforded me.

Those extraordinary efforts put forth under the influence of fear or joy, are instances of volitional increased by being compounded with emotional nervous force. Again, in weeping or laughing, the emotions, by lending their aid, convert that which would have been a half-hearted attempt at laughing or sobbing into the genuine volitiono-emotional movement.

EMOTIONO-REFLEX.

There are certain movements in which the will takes no part, and yet they are compound—the Emotiono-Reflex—actions in which, in addition to the physical stimulus, emotion is necessary. I have already given instances of reflex action being increased by emotion, I shall now adduce one of a reflex action induced by it, which shows clearly how the emotional and reflex may aid each other just as we saw volitional and reflex forces aid each other in deglutition. I refer to the act of vomiting at the sight, odour, or thought, of a disgusting object; a disordered or irritated stomach is highly conducive to this, by the reflex aid of the irritated gastric nerves, and so on. Here the will *necessarily* plays no part; nay, it may do its utmost to prevent the act.

THE VOLITIONO-EMOTIONO-REFLEX.

In this we have a still more complex series of movements, providing for a vast variety of intricate and therefore important instinctive acts.

In this, either of the three elementary parts may take precedence of the others—may assume a part in the act of minor importance than they, or they may equally share in its production. Suffice it to say, that they must each take a part, however small or great, to make it a Volitiono-Emotiono-Reflex act.

I adduce, as an instance of this, the act of sexual intercourse. Here Volition controls, Emotion increases as the stimulus becomes stronger, and a physical stimulus is necessary to complete the act which the others begin.

Having thus delineated the kinds of movements which *must* compose the actions of our own bodies, and knowing no other source of movements in the lower animals, let us now see whether we are able to attribute all their instinctive acts to these; and if so, to which of them chiefly. We will thus rightly eliminate the source and composition of their instinctive movements.

First, then, I would remark that Emotional movements are of two kinds, the *Centric* and *Eccentric*, according as they take their origin from a thought or feeling conceived by the mind without any external stimulus, or from something presented to the mind through the senses and calling forth a corresponding and appropriate action.

As an instance of the former, we adduce the expressional movements, which are a correct index to the frame of mind. As instances of the latter, we have a vast variety of movements, of which I shall adduce examples, showing that the so-called instinctive acts are chiefly due to them—that is, due to external objects acting on the mind or emotional centres, and calling forth corresponding movements; and it will be seen that these responses are in many cases as exact and certain as those reflex acts which follow the application of a physical stimulus. In a sense, therefore, they are as distinctly reflex as many of those acts which more strictly possess that name. In this view, an animal becomes an exquisitely-devised machine, in which certain springs require but to be touched in order to elicit certain movements. That it is so with regard to reflex movements, such as deglutition and respiration, is admitted by all; and we hope to show that it is as much so, but in a more intricate way, in the production of *emotional* movements. This we affirm to be the clue to all those wonderful powers which reside in animals, enabling them to do many things far surpassing the skill and ingenuity of man. But it may be asked, are not these actions far too complicated to arise in this way? To which we answer, that acknowledged reflex movements, such as respiration, are quite as complicated as those movements to which we refer in their *individuality*, and why should not a succession of emotions, excited by a succession of impressions, or a continuous emotion excited by a continued impression, produce a succession of movements, or a continuance of a set of movements which, in their totality, make up the instinctive habits of an animal. Instinct, in this way, becomes mainly dependent on the feelings or emotions which follow appropriate and peculiar stimuli; and which respond by exciting movements as peculiar and appropriate, so that we may, with tolerable cer-

tainty, calculate from a given stimulus applied to a given animal what the resultant movement or effect will be.

Let us apply these suggestions to those movements which in animals are generally connected with the gathering of food, certainly the *first* and *most* important of instinctive acts. When an animal, however young, is left to gather its own food, it is most remarkable to see how soon and how certainly it will choose its own from among a thousand; and in this faculty we see animals to possess a power much above those of man, for even Hippocrates, in his day, saw this and pointed out, that while animals needed no guidance in the choice of their food, man learned his bill of fare by numerous experiments and often painful experience.*

How is this done? That it is mere reflex action cannot be admitted, for we have no instance of a reflex action apart from the application of a physical stimulus to a nerve. Something more, therefore, is needed, and this we find in the responding power of the emotional centres, more or less combined with volition and reflex action as the case may be, and constituting with them, one or other of the compound movements described above, and these emotional acts of instinct are produced in one of two ways—either there is in the nervous system an apparatus so delicate, that the recognition of an object through the senses at once excites to action nerve centres, which emit nervous power of the kind and degree which produces the prehensile act of feeding, or the recognition by the mind or immaterial principle, of a certain property in an object of food, excites an emotion which produces a prehensile act, as certainly as a look or gesture of surprise or fear follows a sudden or unwelcome visitor. Each object or substance would, in the former case, have to act upon certain cells or centres, and *those only*. Certain cells or emotional centres must be supposed to exist capable of responding to the animal's food, and none other than it, other centres would respond to objects calling forth the acts of nursing,

* Hipp. De L'Ancienne Med. p. 3. Libré Ed.

self-defence, attack, &c. In this, the former case, the emotion felt is the effect of the reception of stimulus on the nerve-centre, just as much as the movement produced. In the latter case, it is the immediate effect of its reception by the mind, and *it*—the emotion—is the cause of the resultant movement in exactly the same way as volition is the cause of voluntary movements. In emotional movements, the mind receives, and emotion results and acts; in voluntary movements, the mind receives, and volition results and acts. In this way the young mammal finds its mother, her breasts, her milk, and no other source of food. The bird finds its appropriate stimulus in the insect, the bee in her pollen and nectar, and so on throughout the whole animal kingdom. Of course, we admit that volition controls, aids or restrains in all these acts, for none are purely automatic, so also reflex action may play a part; *but we contend that* EMOTION *is the prime mover in calling forth instinctive acts.*

I will now adduce another series of examples, as it is impossible to multiply those of the same kind in a paper which is suggestive rather than exhaustive.

In the act of sexual intercourse, we have distinct evidence of emotion being excited in response to only one kind of stimulus; and in those lower animals where there is a period of heat, when of course the stimulus is strong, the male animal, even against his will, is at the mercy of his passions, and following his instinct *i. e.* the force of the emotion produced, is committed to the act necessary to the propagation of the species. Let it be noted here that while man is endowed with volitional power to control his animal appetites, in the lower animals volition is much weaker, and emotion stronger; and in the lowest forms of animal life, the two higher forms of nervous power almost disappear, and leave the animal to the care and control of reflex action alone.

How striking is the certainty and the rapidity of action, which the sight of his prey will call forth in the most untutored animal. The prey is the stimulus which calls forth predatory or prehensile movements. The will is quite subordinated to the emotion or feel-

ing in most cases, and the animal, left to his propensities, follows what are called his instincts, and he performs a volitiono-emotional act. Let me again note, that it is by nature that an animal is led to his own prey, and none else—*i. e.* his emotional centres are excited by their own peculiar stimulus, and by that alone. To some dogs, whose nature it is to retrieve or carry, the sight of a rolling stone is enough to call forth the emotiono-volitional act of carrying, and so on.

What we contend for, therefore, is this—"That the emotional centres emit motorial force resulting in instinctive movements, in response to stimuli just as certainly (if not modified by volition) as the ordinary cerebro-spinal centres emit reflex movements in response to physical stimuli."

The sight, the odour, the voice of his master, is quite enough to produce the emotional gambols of a faithful dog; and the footsteps or voice of a stranger will act in exactly the opposite manner, and produce the bark or growl. Surely this is not reason, but emotion, acting in response to its stimuli, just as certainly as reflex movements respond to theirs.

In this sense we might classify reflex actions into the physical and the psychical or emotional.

If it be denied that the emotional centres, wherever they are, can be capable of acts so complicated as those of instinct, then we at once ask whence they come? If they are purely volitional, they must be the result of reason in the animal itself, and our opponent must acknowledge the lower animals to be possessed of reasoning power far superior to that of man. If also an intricate and exquisitely-devised mechanism be necessary to the varied acts of instinct, is there not intricacy and device enough to be found in nervous centres, even the most ordinary?

Our conclusion, then, is this—"The emotional centres are so constructed as to receive certain stimuli, and emit in response to them, movements which, modified by volition and reflex action, make up the chief part of instinctive acts."

If, now, we apply our eliminating process to the investigation of instinctive acts, keeping in mind that all movements *must* be *volitional*, *emotional*, or *reflex*, we shall at once see how admirably it works. All that part of an act which is volitional must be the result of reason or experience, this therefore we eliminate as the share of reason or experience. All that remains is either *reflex* or *emotional*, but we can have nothing *reflex* without a physical stimulus. We therefore deduct this as the exponent of the reflex part of the act; nothing now remains but the emotional, and thus the act is analyzed and simplified. What part does volition, as the servant of reason and representative of experience, play in these actions? We affirm—the all-important part of controlling, checking, or encouraging that which the emotions suggest, and the reflex actions attempt. Of this, in our own persons, we are all aware. Why should it not be the same in the lower animals? In them, of course, volition has not that supreme advantage over the emotions and reflex action which it possesses in man, inasmuch as these functions are much more exalted. We all apply this principle in practice, for we never control an animal by appealing to his reason, but by working on his feelings, and thus leading his instincts.

From all this it appears that the instinctive movements of animals, do not differ from those of man *in kind*, but in degree.*

In man, the volitional, as representing reason, abstract deduction, and experience, is immensely superior to the others. As we

* Let us not be understood to say by this, that man is but an exalted and developed animal; for while we do hold that the instincts of man are of the same nature as those of the lower animals, sharing as he does with them, the instincts of parental love, self-protection, anger, fear, and the like, we at the same time hold that it is not by these that we are to seek to distinguish him from animals any more than by his mere physical construction. He ever must remain separate from them by something higher in his nature than these—viz., by his power of abstract reasoning on things not seen—by his power of self-examination—by his being able to hear and attend to the voice of conscience—by his being able to distinguish in the abstract between right and wrong, good and evil—by the inward cravings of his nature after something higher and better than his present state, and above all, by his being able to appreciate in others the higher qualities of the soul, and to adore them in their perfection as evinced in the one, true, and real instance of "DEIFIED HUMANITY."

descend in the scale, we find the emotional, as the originator of the purely and really instinctive movements, become most prominent, and generally carrying the will with it, for we seldom see an animal going contrary to its instincts. Lower still in the scale, we find all the acts necessary to the life of the animal left to the care and control of reflex action.

Is there then, in animals, an intelligence? We strongly incline to the belief that there is, and that it varies in its power with the kind of animal, and manifests its existence by the extent to which it controls the emotional or purely instinctive part of his actions.

The question, whether he has an imperishable immaterial principle within, is not within the limits of this paper; nor, again, do we discuss the possibility of that which is after the pattern of man ever becoming likened into the image of man, but conclude what we feel keenly to have been but groping in a field of knowledge which is extremely dark, but for that reason all the more interesting, by stating our opinion, that when elucidated it will be found to coincide most clearly with the teachings of revealed religion, and thus we shall find another proof that the Bible and Science do not disagree, but each in its place is true and right, working together for the good of man and the glory of God.

THE DIAGNOSTIC VALUE

OF AN

ACCENTUATED CARDIAC SECOND SOUND.

By J. WARBURTON BEGBIE, M.D.,
PHYSICIAN TO THE ROYAL INFIRMARY.

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It is now universally admitted that the second sound of the heart is produced during the act of closure of the semilunar valves in the orifices of the aorta and pulmonary artery. The sudden tension of the membranous structure of which these valves are composed is a sufficient, possibly the *only*, cause of the sound. It is, however, probable that, as generally held, the recoil of the blood against the valves contributes to its production.

Careful clinical observation has materially aided the direct experiments which, at a former period, were made regarding the heart's sounds. As respects the second sound, it may indeed be concluded that, by the former means of research, much left unfulfilled by the latter has been supplied. For example, I may refer to one or two particulars of importance, which have a special bearing on the subject of this paper. When the second sound is entirely replaced over the base of the heart by a murmur, it is not audible over the ventricles, and is not to be detected at the apex of the organ. In other words, when the murmur of aortic regurgitation is so loud as to drown all normal second sound, preventing, by its very loudness, the recognition of the pulmonary second sound over the pulmonary valves, or in their immediate neighbourhood, where the second sound originating there is most readily heard, it cannot be detected even in small part over any other portion of the heart. Here, however, there are some points worthy of special observation; they concern what may be called exceptional cases of aortic insufficiency. A diastolic murmur may largely obscure, but not obliterate, the second sound over the aortic valves, a portion of it remains; and in such cases, the pulmonary second sound being either readily appreciable or at least audible, the murmur diminishing in loudness as the stethoscope is placed over the ventricles, the normal second sound, pulmonary in origin, or the portion of aortic second sound which remains, is with greater readiness discovered there, or even at the left apex, than at the base. In endeavouring to account for this circumstance, it must be held in remembrance that the murmur of aortic regurgitation is not conducted with anything like the same distinctness over the ventricles as it is down the course of the sternum to the very limit, in some instances, of the ensiform cartilage itself. I have found not unfrequently that the second sound, greatly obscured by murmur at the base, and having precisely the same character at the end of the sternum, has been partially unclouded at the left apex, and over the ventricles a little less so. In such instances, it has not been difficult to determine that the more ready recognition of the sound in the latter situations has been due to the loss in distinctness sustained by the murmur.

Dr Walshe has noticed "a distinct sound at the left apex in more than one case, while at the aortic base the ordinary regurgitant murmur alone existed."[1] So also in cases in which the second sound at the base is only feebly heard—no murmur existing—there may be, if not a loud, at all events a more readily recognised second sound near or at the apex. To such instances Skoda has directed attention, and they have likewise been fully considered by Dr Walshe. In explanation of their occurrence it may be, as Skoda has suggested, and Dr Walshe is disposed to allow, that some of the phenomena occurring during the diastolic action of the ventricles, which are properly, or rather naturally, soundless, become attended by sound,—in other words, produce a second sound of their own; or it is equally conceivable—although perhaps not fully established—that certain diseased states in existence may determine a sound bearing a resemblance, more or less exact, to the normal diastolic sound of the heart.

These few observations I have made by way of preface to the statement of great practical value which I now wish to consider,—That an accentuated condition of the heart's second sound is heard in connexion with one or other of two conditions of disease,—aneurism of the aorta, or dilatation of the aorta. It is hardly necessary to say, that no account is taken here of the by no means uncommon phenomenon of an accentuated pulmonary second sound. All careful auscultators know of how much value that phenomenon is in relation to the condition of mitral valve constriction. In describing the heart's second sound as accentuated in the instances of aortic aneurism and aortic dilatation upon which the present observations are based, it is perhaps necessary to explain that the expressions, intensified, or greatly pronounced, would equally well indicate the character of the sound which has been found to exist. When occurring under the circumstances referred to, the accentuation of the second sound is always well marked. I have frequently observed that early auscultators have, unaided, noticed the peculiarity, while very rarely indeed has there been any difficulty attending its recognition by such, when their attention has

[1] Diseases of the Heart, 3d edition, page 65.

been called to the subject. In a case of aortic aneurism under my care last summer, there existed so accentuated a second sound over the base of the heart as to arrest the notice of all who examined the patient by auscultation. Several students, merely tyros in the art, readily recognised the *booming* character of the sound.

When the accentuated second sound occurs in connexion with aortic aneurism or aortic dilatation, it may be presumed that the semilunar valves are competent. Their insufficiency and the occurrence of an accentuated second sound are inconsistent; if the former lesion be in existence, a diastolic murmur is the necessary result. The influence of valvular disease in the production of murmurs in cases of aortic aneurism is a point of the greatest importance for consideration. There may be, of course, associated mitral valve disease, or tricuspid disease, and, if so, murmurs may be thus originated; but such association is to be regarded rather in the light of an accidental coincidence, and not by any means of the same importance as the occurrence of disease of the aortic valves. Judging from cases of aneurism which have come under my own observation in hospital, I conclude that it is very common to find aortic valve insufficiency in connexion with aortic aneurism; while in such cases the diastolic murmur, usually a very loud or at least very distinct one, so characteristic of the former lesion, is the most prominent auscultatory phenomenon. The cases now referred to are very evidently not cases of valvular disease in the first instance, and subsequently of aneurism; in none has there been any foregoing attack of rheumatism, in none any distinct rheumatic history. Neither are they examples of a mere accidental association. The relation of the valvular imperfection to the aneurism is, I believe, of the greatest interest and importance, and in all, its occurrence has been subsequent to the disease of the vessel. If an aortic aneurism attain to any considerable dimensions, and affect the ascending portion of the arch, the aortic valves are rendered incompetent; and being so we shall find the auscultatory phenomena connected with the latter lesion in existence, and likewise the other physical signs which afford such evidence, especially the well-known peculiarities in the pulses, as pointed out by Dr Corrigan and Dr Henderson. I never remember to have seen an instance of aneurism of the aortic arch within the pericardium of any considerable size unattended by diastolic murmur,—the diastolic murmur of aortic valve insufficiency. On the other hand, the prominent physical signs of aortic insufficiency have led me—and no doubt the same error has been committed by others—to overlook the existence of aneurism altogether. Dr Haldane has in his possession a preparation of a large aortic aneurism, removed from a patient who had been under my own observation, as well as at different times under the care of three hospital physicians. In this case the signs of insufficiency of the semilunar valves were of unusual distinctness, and so, during the patient's life, the existence of that lesion was recognised, while the aneurism escaped detection till after death. The fatal event occurred suddenly, not from rupture of the aneurism, but after the mode in which a very sudden termination not unfrequently takes place in cases of aortic insufficiency. With these facts before us, how necessary is it to make a careful use of the other means of diagnosis, in addition to auscultation, which we possess.

There is no diseased condition within the chest which gives rise to so many and different auscultatory signs as aneurism. I have no intention at present of making any detailed reference to these. My remarks will be limited now to one peculiarity,—the *accentuated* second sound. Here I purposely avoid making any mention of the systolic cardiac sound. Of course, in all cases, it is of importance to determine its true state, whether pure, or itself accentuated, or attended by murmur; any of these it may be, while the accentuated character of the second sound prevails. Now, as the result of careful observation and continued attention, I have found that, excluding the accentuated pulmonary second sound, and the intensified aortic second sound in some cases of hypertrophy and dilatation of the left ventricle, the accentuated second sound in the aorta is an indication of aortic aneurism, or of dilatation of the aorta associated with atheromatous degeneration. If it be the former, the aneurism probably does not arise within the pericardium, and probably does not affect the ascending portion of the arch, but has most likely its seat in the transverse portion; it may, however, arise at an earlier part of the aorta, as was found in the following case:—

Aneurism of the Aorta, pointing externally, bursting through the Lung into the Left Pleura.

S. M., æt. 36, under my care in the Infirmary, Ward V., during August and September 1862. Between the second and third left ribs, near their cartilages, a pulsating tumour was detected on the patient's admission. On auscultation a soft bruit was audible over the tumour; and at the base of heart, as well as over the upper bone of sternum, a very loud ringing second sound. The latter phenomenon never varied during the patient's six weeks' residence in hospital. He died suddenly, after expectorating a little blood. On examination of the body after death, serous fluid and coagulated blood, to the amount of more than half a gallon, were found in the cavity of the left pleura; the heart was pushed downwards and backwards; it weighed fourteen ounces. *The valves were perfectly healthy.* An aneurism was found commencing abruptly an inch and a half above the semilunar valves,—the whole vessel suddenly dilating to a point immediately beyond the origin of the left carotid, where the dilatation as suddenly ceased. The pouch so formed was six inches in length; it passed behind and was applied to the back of the manubrium sterni, and made its appearance externally between the second and third left ribs. The left extremity of the sac was intimately united to the left lung, the edge of which had become

thinned by pressure, and the pleura having then given way, allowed the escape of the aneurismal contents into the pleural sac.[1]

In the foregoing case the peculiarity of the second sound was of comparatively little value in leading to the recognition of the aneurism, other and still more distinctive signs, especially the visible pulsating tumour, of that condition being in existence; but the accentuated sound led to the diagnosis of the competency of the semilunar valves, which post-mortem examination confirmed. In the following case the accentuated second sound was the earliest noted reliable sign of aortic aneurism.

W. M'A., æt. 35, a hawker, was first seen by me in March 1862, complaining of slight chest symptoms, particularly cough and expectoration of a little phlegm. Had not been a sober man.

Condition on first examination.—Has a slight bronchitic affection. Heart's second sound markedly accentuated over the aortic valves. No other auscultatory phenomenon connected with heart or great vessels.

I had frequent opportunities of seeing and examining this man up to November 6th, when he entered the Infirmary, becoming a patient in Ward IV. During this time his general health had failed considerably; he had become thinner, feebler, less able for his occupation, though still moving about and doing something as a traveller.

On 6th November the following notes of his condition were made. Has been suffering from dyspnœa, which has seized him on a few occasions suddenly, and without any previous effort or exertion having been made. Cough is somewhat clanging in character. Has some pain and peculiar sense of weight in region of sternum. Over the left portion of manubrium there is visible pulsation,—the latter readily distinguished on ~~pulsation~~. Left palpation radial pulse is feebler than right. Murmur of soft blowing character accompanies first sound over the seat of pulsation, and is heard less distinctly over the base of heart. The second sound at base is of a loud *booming* character. Respiratory sounds in upper part of left lung, feeble. Posteriorly there is a little bronchial stridor.

This man, so far as I know, survives: he left the Infirmary about eight weeks since. With such signs as those detailed, the existence of aneurism becomes unquestionable, they have become gradually developed in succession to the accentuated second sound, the earliest noticed of all.

Of this kind I might furnish other examples, several are known to me; and the opportunity has occurred for directing the attention of students to these, in the ordinary course of clinical instruction.

I have further to remark, that a similar condition of the second cardiac sound may be caused by dilatation of the aorta, associated

[1] The post-mortem examination was performed by Dr Haldane, at that time Pathologist to the Royal Infirmary, and the account given above has been abbreviated from his record of dissections.

with more or less of atheromatous degeneration. To distinguish between the two,—in other words, to know when the accentuated second sound is due to aneurism and when to dilatation of the aorta, is not always easy. Reliance is chiefly to be placed on the associated physical signs in the former case, more particularly prominence, pulsation, extended percussion dulness, and the signs of internal pressure. If atheromatous dilatation exist, and that is the special condition, independent of aneurism, which gives rise to the accentuated second sound, there will probably be more or less pulsation in jugular fossa, atheromatous condition of superficial pulses (radials, temporal arteries, etc.) noticeable, and probably the arcus senilis.

The following points appear to me to be of importance in endeavouring to explain the mechanism of an accentuated second sound, under the circumstances now considered :—

1. The condition of the vessel, both in cases of aneurism and of dilatation with atheromatous degeneration, being such as greatly to diminish, if not to destroy, the support given to the circulation by the artery, there results an increased recoil of blood on the closing or closed valves.

2. It is possible that a morbid condition of the valvular apparatus itself heightens or intensifies the sound. The valves are not incompetent, but in such cases they are sometimes found thickened, and even presenting a hard surface at parts.

3. Something may, I conceive, be due to the increased calibre of the vessel, in connexion with the altered condition of its internal tunic, in causing the peculiarity of sound.

But in whatever way the phenomenon is to be correctly explained, there can be no doubt of its existence being entitled to very considerable value as a clinical fact. I have noticed that the accentuated second sound is most readily appreciable over the aortic valves in both conditions. In the cases of dilatation of the aorta it has, however, been more decided in character over the manubrium sterni than in aneurismal cases. I may add, that in the majority of cases observed by myself, in which the accentuated second sound has existed under the circumstances now detailed, the expression, *booming* second sound, or second sound with *ringing boom*, has best described the acoustic character of the sound itself. I have known the booming sound continue for many weeks, and in one remarkable case of aneurism lately observed (Walker, in Ward V., and afterwards in Ward IV.), for months, and thereafter become at first obscured, and ultimately entirely replaced by a loud diastolic murmur, telling plainly that the semi-lunar valves had become insufficient owing to the extension of the disease towards the heart.

EDINBURGH: PRINTED BY OLIVER AND BOYD, TWEEDDALE COURT.

With the author's respects

ON THE

COAGULATION OF THE BLOOD.

THE CROONIAN LECTURE

DELIVERED BEFORE THE ROYAL SOCIETY OF LONDON

11TH JUNE 1863.

BY

JOSEPH LISTER, F.R.S.,
Professor of Surgery in the University of Glasgow.

[*From the* PROCEEDINGS *of the* ROYAL SOCIETY.]

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The subject on which I have the honour to address you this evening, is one which lies at the foundation both of Physiology and Pathology, and, on account of its great importance, has engaged the best energies of many very able men, among whom may be mentioned, for example, such distinguished Fellows of this Society as John Hunter and Hewson; so that it might well seem presumptuous in me to hope to communicate anything new regarding it, were it not that the constant progress of Physiology and the allied sciences is ever opening up fresh paths for inquiry, and ever affording fresh facilities for pursuing them. Indeed, my difficulty, on the present occasion, does not depend so much on the lack of materials as on the complicated relations of the subject, which make me almost despair of being able, in the short time that can be devoted to a lecture, to give, in anything like an intelligible form, even an adequate selection of the facts at my disposal.

It may, in the first place, be worth while, more especially for the sake of any present who may not be physiologists, to mention very briefly some well-known general facts respecting the constitution of the blood. The blood, if examined by the microscope within the vessels of a living animal, is seen to consist of a liquid and numerous small particles suspended in it. The liquid is termed the "liquor sanguinis," the particles the "blood-corpuscles." Of these corpuscles a few are colourless, and are named the "colourless" or "white corpuscles." The great majority are coloured and cause the red appearance of the blood, and hence are called the "red corpuscles." Soon after blood has been shed from the body, it passes from the fluid into the solid form. This depends upon the development in the blood of a solid material termed "fibrin," so called from its fibrous nature, consisting, as examined by the naked eye, of tenacious fibres, and having the same character also under the microscope. These fibres form a complicated network among the blood-corpuscles, and from their tenacity are the cause of the firmness of the clot. Soon after the process of solidification or coagulation is complete, the fibrin exhibits a disposition to shrink, and squeezes out from among the corpuscles entangled in its meshes a straw-coloured fluid termed the serum, very rich in albumen, in fact very similar in chemical composition to the fibrin, which, in its turn, may be said to be identical chemically with the material of muscular fibre.

The question before us, therefore, is, What is the cause of the development of this solid material, the fibrin? The subject may be looked at in two aspects,—first, as to the essential nature of the process of coagulation; and secondly, as to the cause of its occurrence when the blood is removed from the body.

With regard to the first point, the essential nature of the process of coagulation, different views have been entertained. John Hunter was of opinion that the coagulation of the blood, the solidification of the fibrin, was an act of life—analogous, in some respects, to the contraction of muscular fibre. This, on the other hand, was made very unlikely by the observation of his contemporary, Mr. Hewson, that blood may be kept in the fluid state by the addition of various neutral salts, but retains the faculty of coagulating when water is added to the mixture. Mr. Gulliver, on one occasion, kept blood fluid, by means of nitre, for upwards of a year, but found that it still coagulated on the addition of water. It seems exceedingly improbable that any part of the human body should retain its vital properties after being thus pickled for more than a year. But here I would wish to make an explanation of the use of this term "vital properties." When employing it, I do not wish to commit myself to any particular theory of the nature of life, or even to the belief that the actions of living bodies are not all conducted in obedience to physical and chemical laws. But it appears that every component tissue of the human body has its own life, its own health, just as we ourselves have; and as the actions of living men will ever retain their interest whatever views be entertained of the nature of life, so must the actions of the living tissues ever continue to be essential objects of study to the physiologist and pathologist. When, therefore, I use the term "vital properties," I mean simply properties peculiar to the tissues as components of the healthy living body.

Turning now to the other aspect of the subject of coagulation—the cause of the occurrence of that process on the escape of the blood from the living body—we find that here again various theories have been held, which may be divided into mechanical, chemical, and vital. The mechanical theory was, that mere rest of the blood was sufficient to cause coagulation. I say this *was* the theory; but I believe it will be found to be still taught by many, that the cause of the coagulation of the blood in an artery which has been tied is its stagnation in the vicinity of the ligature.

As to the chemical theories they have been various. One very natural view was, that exposure to the air was the essential cause of coagulation. Mr. Hewson believed that this was, at all events, an important element in the causes of the phenomenon; and many eminent physiologists and pathologists have held the same view, except that, instead of the air as a whole, the oxygen of the air has been supposed to be the important element.

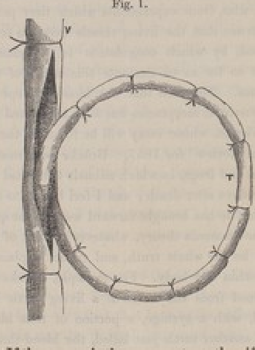
Sir Charles Scudamore considered that coagulation was greatly promoted by the escape of carbonic acid; and more recently the evolution of ammonia has been regarded as the essential cause of the change. According to the ammonia theory, due to Dr. Richardson of this city, the fluidity of the blood within the body depends on a certain amount of free ammonia holding the fibrin in solution, and the coagulation of the blood when withdrawn from the vessels is the result of the escape of the volatile alkali.

Then, as to vital theories. These have been held by many physiologists, among whom may be mentioned Sir Astley Cooper and Mr. Thackrah, who, from experiments which they performed, were led to the inference that the living vessels exert an active influence upon the blood, by which coagulation is prevented; and Mr. Thackrah went so far as to attribute this action of the vessels to nervous influence. The view that the blood is kept fluid by the operation of its natural receptacles has been advocated more recently by Brücke of Vienna, whose essay will be found in the 'British and Foreign Medical Review' for 1857. Brücke performed his experiments on turtles and frogs, in which animals the blood remains fluid in the heart for days after death; and I feel bound to say that some of the facts which he has brought forward seem to me quite sufficient to show that the ammonia theory, whatever amount of truth it may contain, cannot be the whole truth, and cannot explain the fluidity of the blood within the body. For example, Brücke found that, having shed blood from the heart of a living turtle into a basin, and transferred, with a syringe, a portion of that blood into the empty heart of another turtle just killed, the blood thus transferred into the empty heart remained fluid for hours; whereas that which was left in the basin coagulated in a few minutes. He also found that blood continued fluid in the heart of a turtle long after the injection of air into the heart through a vein till the cavities of the organ contained a foamy mixture of blood and air.

Yet it by no means follows that the vital theory and the ammonia theory are necessarily altogether inconsistent. It might be true for anything we could tell, *à priori*, that the coagulation of the blood, when shed from the body, might depend on the evolution of a certain amount of ammonia, previously holding the fibrin in solution, and yet it might, at the same time, be true that the cause of the ammonia remaining in the blood in the healthy vessels might be an action of the living vessels retaining it there. It might be that an action of the living vessels might chain down the ammonia and prevent it from escaping, whereas, when shed from the body, it would be free to escape.

This notion was, I confess, at one time entertained by myself; and one of my earliest experiments was performed with a view to the corroboration of the ammonia theory as applied to blood outside the body. It seemed to me desirable that further evidence should be afforded of the effect of mere occlusion from air in maintaining the

Fig. 1.



blood fluid. If the ammonia theory were true, then if blood could be shed directly from a living vessel into an air-tight receptacle composed

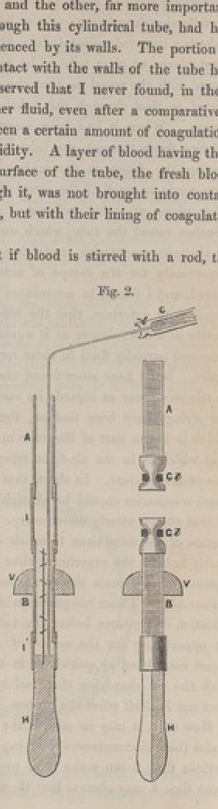
of ordinary matter it ought to remain fluid. For this purpose, I made the following experiment:—I tied into the jugular vein, V, (fig. 1) of a sheep a long vulcanized india-rubber tube, T, adapted by means of short pieces of glass tube at its extremities, both ends being connected with the vessel so that the current of blood might be permitted to flow through the tube, and then continue its natural course. When it had been ascertained that the blood was circulating freely through the tube, which could be readily done by placing the finger on the cardiac aspect of the vein, which was then made to swell if the circulation was proceeding through the tube, pieces of string well-waxed were tied at intervals of about 2 inches round the tube, which was thus converted into a number of air-tight receptacles containing blood, which certainly had no opportunity for the escape of ammonia. The tube was then removed, and I found, in accordance with the view which I was then disposed to entertain, that the blood, instead of coagulating completely in a few minutes as it would have done if shed into a cup, remained partially fluid in these receptacles after the lapse of three hours. But I have since found that if the experiment be repeated in the same way as regards its earlier stages, and if, after a few of the strings have been tied on, the tube be cut across, the blood which is in the part of the tube in the vicinity of the air, just like that which is in the air-tight receptacles, remains fluid in part for two or three hours. In short, that my precautions in ensuring that these receptacles should be air-tight were, in so far as they applied to that object, utterly unnecessary. I mention this partly as an illustration of the deceptions to which one is liable in this inquiry, and partly because the experiment thus modified seems to tell as clearly against the ammonia theory as the original one seemed to tell in favour of it. Those receptacles which had been formed by the application of ligatures before the tube was opened afforded certainly no opportunity for the escape of ammonia, and yet in them the blood coagulated as quickly as in those which had communication with the air—implying that facility for the evolution of ammonia does not in itself affect the process of coagulation at all.

How then, it may be said, is the persistent fluidity of the blood under these circumstances to be explained? That will become more obvious than I can make it at present in the sequel; but in the mean time I may observe that there are probably two explanations:

one is, the coolness of the tube, and the other, far more important, that the blood, in slipping through this cylindrical tube, had had little opportunity of being influenced by its walls. The portion of the blood that came first in contact with the walls of the tube had coagulated; and it is to be observed that I never found, in these experiments, the blood altogether fluid, even after a comparatively short time: there has always been a certain amount of coagulation, and only a certain amount of fluidity. A layer of blood having thus coagulated upon the internal surface of the tube, the fresh blood which continued to flow through it, was not brought into contact with the walls of the tube at all, but with their lining of coagulated blood.

It has been long known that if blood is stirred with a rod, the process of coagulation is promoted. It seemed desirable to ascertain distinctly whether the cause of this was the contact of the foreign solid, or the opportunity given for the escape of ammonia; for it is quite true that, in the ordinary process of stirring blood, more or less air is mixed with it. For the purpose of determining this I devised a somewhat complicated experiment, which, however, it may be worth while to mention. I made an apparatus (fig. 2) of two portions of glass tube, A and B, connected in a vertical position by means of vulcanized india-rubber, I, the lower portion of the glass tube being also connected by india-rubber, I′, with a wooden handle, which handle, H, was provided with an upright piece of wire, from which spokes projected in different directions, so

Fig. 2.



that they would, when moved, act as a churn on any blood contained in the lower portion of tube. When the lower piece of tube was fixed by means of a vice, V, the flexibility of the india-rubber permitted the churn to be rotated so as to expose the blood to its influence. This having been arranged, I first poured in strong *liquor ammoniæ*, so as to get rid of any slight acidity which the constituents of the apparatus might be conceived to possess, and then, having poured out the ammonia, filled up the apparatus with water, and boiled the whole in a large glass test-tube till all bubbles of air, in any portion of it, were expelled. Having then tied into a branch of the carotid artery, C, of a calf a bent tube of small diameter, as represented, and having permitted the blood to flow till it escaped at the orifice of the tube, I compressed the artery and passed the tube down through the water to the bottom of the apparatus, and then let the blood flow again, which had the effect of displacing all the water; and when the blood appeared at the top of the apparatus, the tube was withdrawn, when two effectual clamps, Cl, Cl, were placed on the vulcanized india-rubber connecting A and B; the india-rubber was then divided between the clamps, and we had the state of things represented at the right-hand side of the diagram. The upper portion of the apparatus, the orifice of which was exposed to the air, was set aside and left undisturbed. Having ascertained that the lower portion had been effectually sealed by the clamp, and thus prevented from any opportunity of escape of ammonia, I subjected it to the action of the churn for a certain number of minutes. It so happened that the blood of that calf was very slow in coagulating. I knew this from previous experiments on the animal, and therefore continued the action of the churn for a considerable time, viz. thirty-seven minutes. I then found the wire enveloped in a mass of clot; and examination of the fluid residue with a needle indicated that the fibrin had been all withdrawn from the blood on which the churn had acted. I did not now examine the other portion of the apparatus, which had been set aside; but at the end of an hour and a quarter, when more than double the time had elapsed, I investigated this, and found the blood in it, for the most part, still fluid and coagulable. Thus the blood in the churn, which, from the time it left the artery, had no opportunity of parting with its ammonia, coagulated much more rapidly than that in an open vessel. The difference between the two was, that the lower portion of the blood had been freely exposed to the influence of the foreign solid, whereas the other had only been subjected to the action of the wall of the tube.

The same principle may be illustrated by an exceedingly simple experiment which I performed only this very day. Receiving blood from the throat of a bullock into two similar wide-mouthed bottles, I immediately stirred one of them with a clean ivory rod for 10 seconds very gently, so as to avoid the introduction of any air, and then left both undisturbed. At the end of a certain number of minutes I found that, while the blood which had not been disturbed could be poured out as a fluid, with the exception of a thin layer of clot on the surface, and an incrustation on the interior of the vessel, the blood in the other vessel, which had been stirred for so brief a period, was already a solid mass.

I have only lately been aware of the great influence exerted upon the blood by exposure for a very short time to a foreign solid, and I feel that many of my own experiments, and many performed by others, have been vitiated for want of this knowledge. Take, for example, the effect of a vacuum, which was observed by Sir Charles Scudamore to promote coagulation. This has been considered by Dr. Richardson as an illustration of his theory, the vacuum being supposed to act by favouring the escape of ammonia. I have lately inquired into this subject, and I feel no doubt whatever that the greater rapidity of coagulation in a vacuum depends simply on the greater disturbance of the fluid. I made the following experiment:—I filled three bottles, such as these, from the throat of a bullock, placed one of them under the small bell jar of an air-pump in good order and exhausted it, leaving the other two undisturbed. The blood happened to be slow in coagulating; and at the end of about forty minutes, in the vessels where the blood had been undisturbed, there was only a slight film of coagulum on the surface, whereas the blood under the vacuum was found on examination to have a very thick crust of clot upon it. But during the process of exhaustion the blood had bubbled very much. Indeed, any exhaustion of blood recently drawn which is sufficient to cause the evolution of its gases

induces great bubbling; so that the pump cannot be used freely, for fear of the froth overflowing. To this disturbance, involving the exposure of successive portions of blood in the bubbles to the sides of the vessel, I was inclined to attribute the more rapid coagulation; but in order to prove the point, I stirred for a few seconds the blood in one of the vessels hitherto undisturbed. After eight minutes I emptied the three vessels. I found that that blood which had not been disturbed at all, either by the vacuum or by the rod, was still almost entirely fluid, only showing a thin crust upon the glass and on the surface exposed to the air. The blood which had been subjected to the vacuum had a thick crust of clot on the surface, and the sides of the glass were also thickly encrusted, but it still contained a considerable quantity of fluid that could be poured out from its interior. But that blood which had been stirred for only a few seconds was a solid mass throughout. In other words, gentle stirring of the blood for a few seconds had much greater effect in producing coagulation than the protracted and efficient exhaustion which was continued for upwards of 40 minutes, which was a considerable time after all evolution of gas, as indicated by bubbles, had ceased.

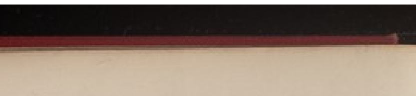
Other experiments precisely similar in their effect were performed. I therefore feel no hesitation in stating that the effects of a vacuum, regarding which, indeed, the statements of different experimenters have hitherto been conflicting, afford no evidence in favour of the ammonia theory.

There is another point of very great interest in the history of the coagulation of the blood, which has been supposed to give support to the ammonia theory; and that is, the effect of temperature. It has been long known that blood coagulates more rapidly at a high than at a low temperature, and, indeed, a little above the freezing-point remains entirely fluid. This seemed beautifully in harmony with the ammonia theory, as heat would naturally promote, and cold retard the evolution of the alkali, and a depression of temperature to near the freezing-point might be reasonably supposed to prevent its escape altogether. Indeed Dr. Richardson mentions as a fact, that ammonia artificially mixed with blood ceases to be given off under such circumstances.

Though thinking it not unlikely that this was the true explanation of the influence of temperature on coagulation, I thought it worth while to subject the matter to experiment. For that purpose I kept the blood of a horse fluid by means of a freezing-mixture, and afterwards by ice-cold water; and when the corpuscles had subsided from the upper part of the blood, I cautiously added to the liquor sanguinis extremely dilute ice-cold acetic acid till it was of distinctly acid reaction, the liquor sanguinis being of a colour that permitted the delicate application of test-paper, which is impossible with red blood. By this means any free ammonia which the fluid might have contained must have been neutralized; yet so long as it was kept in the cold it continued fluid, but when brought into a warm room, coagulated just as a specimen which had not been acidulated. Thus, when there could be no free ammonia in the liquor sanguinis at all, it was still affected as usual by temperature.

This experiment may not be satisfactory to all minds, though I confess it appears so to me; and as this is a point of very great interest, I have sought in another way for evidence regarding it. First, however, I will mention an experiment which will not at once appear to bear on the question of temperature. I drew out a fine glass tube in such a way as to produce a fusiform receptacle continued longitudinally each way into a tube of almost capillary fineness for about two inches, which again expanded at the end, as represented in fig. 3. Having squeezed out a drop of blood from my finger, I

Fig. 3.



sucked up a portion into the tube till the receptacle A and its capillary extensions were filled. I then broke off the expanded ends, and placed the little tube thus filled, B, in a bath of the strongest liquor ammoniæ. Here certainly the blood was in circumstances in which it could not lose ammonia, but where any change in its amount must be by way of increase, and yet I found, on opening the receptacle by

snapping it across after a scratch with a file, that instead of remaining longer fluid than in a watch-glass, the blood in it, being more in contact with the glass, was always more quickly coagulated, while coagulation was still more rapid in the capillary tube, where the blood was still more exposed to the influence of the foreign solid—the greater proximity to the liquor ammoniæ having no influence upon it.

It may perhaps be argued that the drop of blood employed being a small drop, and this small drop having been drawn up by suction into the tube, it might have parted with its ammonia before it got into the tube; but then (and now comes the bearing of the experiment on the effect of temperature) I found, if I placed a similar tube filled in the same way in a vessel of snow, so as not to freeze it but to keep it ice-cold, the blood in it remained fluid as long as I chose to keep it there. Now if all the ammonia had left the blood before it was introduced into the tube, cold ought, according to the ammonia theory, to have had no effect in retarding its coagulation; for, according to that theory, cold operates by retaining the ammonia. On the other hand, if we take the other alternative and suppose that any ammonia which the blood might have contained was still in these tubes, the former experiment proves clearly that the retention of ammonia has no effect in producing fluidity—no effect in preventing coagulation; and if the retention of ammonia has no effect in preventing coagulation, then cold certainly cannot prevent coagulation by retaining the ammonia, because, even if retained, it would not influence the result. In whatever way we look at them, therefore, these simple experiments prove conclusively that cold maintains the fluidity of the blood in some manner unconnected with any influence it may exert upon ammonia.

Then, again, I varied the experiment in this way. I placed such little tubes of blood in baths of liquor ammoniæ at different temperatures. By careful management, guarding against the volatilization of ammonia and consequent reduction of temperature, I succeeded in employing satisfactorily a bath of liquor ammoniæ at 100° F., the blood being in the bath within a few seconds of its leaving the vessels of my finger, and I found that the high temperature, though under such circumstances it could not possibly dissipate any ammonia from the blood, yet accelerated its coagulation in precisely the same way as when it was applied to blood in watch-glasses exposed to the air.

It is clear, then, that the promotion of the solidification of fibrin by heat is as independent of the evolution of ammonia as the coagulation of albumen under the same agency. Indeed it seems probable that the two cases are analogous, except that a higher temperature is required in the one than in the other.

When fine tubes containing blood were placed in liquor ammoniæ, the alkali acted only upon those parts which were close to the ends of the tubes; a very small portion was rendered brown by it, and beyond that a little was kept permanently fluid, but the chief length of the blood in the tube was unaffected. Having thus ascertained that ammonia travels so slowly along tubes of this capillary fineness, I thought I might have an opportunity of giving the ammonia theory a fair test by tying such a tube as has been above described into the jugular vein of a rabbit and filling it directly from the vessel, and then ascertaining whether there was any evidence of retardation of coagulation in the blood thus imprisoned. But I could discover no such evidence, although I sought for it in confirmation of a view I then held. To this, however, there is one special exception to be made, viz. in the case of asphyxia. I found that if two such tubes were filled from the same blood-vessel of a creature, one under normal circumstances, and the other after asphyxia had been induced, there was a most remarkable difference between the rates of coagulation of the blood in the two tubes, the asphyxial blood coagulating very much more slowly than the ordinary blood; but when the asphyxial blood was shed into a watch-glass and air was blown through it, it coagulated rapidly, showing that in the state of asphyxia there must be some volatile element in the blood which has an effect in retarding coagulation.

Supposing at first that this volatile element must be ammonia, I hoped to be able by chemical means to find evidence of its accumulation in asphyxia, and thus add a fact of great interest to physiology. Imitating experiments previously made by Dr. Richardson, I passed air successively through blood and through hydrochloric acid, and then estimated the amount of ammonia acquired by the latter by means of

bichloride of platinum. In order to prevent the possibility of the loss of any ammonia, I directed blood from the carotid artery of a calf fairly into a Woulfe's bottle by means of a vulcanized india-rubber tube tied into the vessel, and then drew a certain volume of air through it by means of an aspirating jar, the experiment being performed first before, and then during asphyxia. The same procedure was adopted with a second calf, the animal being in each case under chloroform, which does not interfere with the development during asphyxia of the peculiarity in the blood above alluded to; but I could not find satisfactory evidence of accumulation of ammonia; and without going further into the question at present, I may say that it seems much more probable that the effect is due to carbonic acid, which is known to have a retarding influence on coagulation, and which probably accumulates greatly in asphyxial blood.

But in justice to the author of the ammonia theory, and to myself, too, who at one time expressed a qualified belief in it, it is but fair to say that this theory is extremely plausible. It has been well shown by Dr. Richardson that ammonia is a substance well fitted to keep the blood fluid if it be present in a sufficient quantity. An experiment of my own illustrates very well the same point. I drew out a tube about a quarter of an inch in calibre (fig. 4), so that while

Fig. 4.

for two inches at one end it retained its original width, the rest (some ten inches) was pretty narrow, though far from having the capillary fineness of those before described. Into the thick part I introduced a drop of strong liquor ammoniæ, A, and then securely corked that end of the tube, C. The object of this was that there should be a strong ammoniacal atmosphere in the narrow part of the tube. I then opened a branch of a vein, V, in the neck of a sheep, introduced the narrow end of the tube into the vessel, and pushing it in so that its orifice should be in the current of the main trunk of the vein, tied it in securely. I then removed the cork and made pressure on the vein at the cardiac side, causing the vessel to swell and blood to pass into the fine part of the tube; and before the blood had reached the part of the glass moistened by the ammonia, I put in the cork again and withdrew the tube. In a short time, on introducing a hook of fine wire into the extremity of the tube, I found the blood already coagulated; but on filing off a small portion of the tube, I found the blood there fluid. The portion of blood thus exposed soon coagulated, when, a second small piece of the tube being removed by the file, fluid blood was again disclosed, which again soon coagulated; and this proceeding was repeated with the same results time after time, till, near the thick part of the tube, the ammonia in the blood was so strong as to prevent coagulation altogether.

This experiment illustrates how fitted the ammonia is to maintain the fluidity of blood, and also how apt it is, when present in the blood, to fly speedily off from it, leaving it unimpaired in its coagulating properties; and it must be confessed that the end of the tube sealed with a small clot resembled most deceptively the extremity of a divided artery similarly closed. But although the experiment seems in so far to favour the ammonia theory, it will tell differently when I mention the object with which it was performed. It appeared to me that, if the cause of the fluidity of the blood was free ammonia, then, if I provided an ammoniacal atmosphere in the tube, and introduced blood by pressure directly from the vein into this ammoniacal atmosphere, this blood, lying between the strong ammoniacal atmosphere on the one side and the ammonia naturally present in the blood within the vein on the other side, ought to remain fluid; and if it did remain fluid, this would tend to confirm the ammonia theory by making it appear that the volatile material was the same at both ends of the tube. But, to my disappointment, I invariably found that if I drew away the tube after a few minutes only had elapsed, there was already a clot in its extremity; in other words, the ammonia had diffused from the end of the tube into the blood within the vein as into a non-ammoniacal atmosphere. This experiment alone, if duly considered, would, I think, suffice to show that the blood does not contain enough ammonia to account for its fluidity.

Fig. 5.

One more experiment, however, may be adduced with the same object. I mounted a short but wide glass tube, open at both ends (T, fig. 5), upon the end of a piece of strong wire, W, and connected with the latter a coil of fine silver wire, S, so that it hung freely in the tube. I then opened the carotid artery of a horse, and through the wound instantly thrust in the apparatus so far that I was sure the tube lay in the common carotid, which in veterinary language means the enormous trunk common to both sides of the neck of the animal. The tube being open at both ends, and slightly funnel-shaped at that end which was directed towards the heart, had thus a full current of arterial blood streaming through it. Having ascertained how long the arterial blood took to show the first appearance of coagulation in a watch-glass, I very soon after removed the apparatus, and, on taking out the coil of silver wire, found that it was already crusted over with coagulum. Yet here assuredly there had been no opportunity for the escape of ammonia.

From this experiment it is obvious that there is a very great difference between ordinary solid matter and the living vessels in their relation to the blood. But the same conclusion may be drawn much more simply from experiments which I had the opportunity of performing after making an observation which it seems strange should have been left for me to make, and which, I may say, was made by myself purely accidentally; and this is, that the blood of mammalia, although it coagulates soon after death in the heart and the principal arterial and venous trunks, remains fluid for an indefinite period in the small vessels. If, therefore, a ligature be tied round the foot of a living sheep a little below the joint which is divided by the butcher, the foot being removed and taken home with the blood retained in the veins by the ligature, we have a ready opportunity of investigating the subject of coagulation, and of making observations as satisfactory as they are simple. Here are two feet provided in the way I have alluded to. A superficial vein in each foot has been exposed. The veins I see have contracted very much since I reflected the skin from them before our meeting; and I may remark that such contraction, dependent on muscular action, may occur days after amputation, indicating the persistence of vital properties in the veins. Now as I cut across this vein, blood flows out, fluid but coagulable. Into the vein of this other foot has been introduced a piece of fine silver wire, and when I slit up the vein you will see the effect it has produced. Exactly as far as the silver wire extends, so far is there a clot in this vessel. Now this experiment, very simple as it is, is of itself sufficient to prove the vital theory in the sense that the living vessels differ entirely from ordinary solids in their relation to the blood. It is perfectly clear that by introducing a clean piece of silver wire (and platinum or glass or any other substance chemically inert would have had the same effect) I do not add any chemical material or facilitate the escape of any, and yet coagulation occurs round about the foreign solid.

Again, if a blood-vessel be injured at any part, coagulation will occur at the seat of injury. As a good illustration of this, and also as bearing upon the ammonia theory, I may mention the following experiment. Having squeezed the blood out of a limited portion of one of the veins of a sheep's foot, and prevented its return by appropriate means, I treated the empty portion with caustic ammonia, the neighbouring parts of the vein being protected from the irritating vapour by lint steeped in olive oil. After the smell of ammonia had passed off, I let the blood flow back again and left it undisturbed for a while, when I found on examination a cylindrical clot in the part that had been treated with ammonia, while in the adjacent parts of the same vessel the blood remained fluid. I repeated this experiment several times and always with the same result. Where the ammonia had acted there was a clot. The chemical agent used here was one which, so long as any of it remained, would keep the blood fluid; yet its ultimate effect was to induce coagulation, the vital properties of the vein having been destroyed by it.

If a needle or a piece of silver wire is introduced for a short time into one of the veins of the sheep's foot, it is found on withdrawal to be covered over with a very thin crust of fibrin, whereas the wall of the vessel itself is never found to have fibrin or coagulum adhering to it unless it has been injured. Now this seems to imply that the

ordinary solid is the active agent with reference to coagulation—that it is not that the blood is maintained fluid by any action of the living vessels, but that it is induced to coagulate by an attractive agency on the part of the foreign solid. We see at any rate that the foreign solid has an attraction for fibrin which the wall of the vessel has not.

And yet I own I was at first inclined to think that the blood-vessels must in some way actively prevent coagulation. There were two considerations that led to this view. One was, that the blood remained fluid in the small vessels after death, but coagulated in the large. Now why should that be? It seemed only susceptible of explanation from there being some connexion between the size of the vessel and the circumstance of coagulation. It looked as if in the small veins the action of the wall of the vessel was able to control the blood and keep it fluid, but that the large mass in the principal trunks could not be so kept under control. The other circumstance was, the rapid coagulation of a large quantity of blood shed into a basin. Why should this occur unless there was some spontaneous tendency in the blood to coagulate? It seemed scarcely credible that it was the result of contact with the surface of the basin.

Both these notions, however, have since been swept away. In the first place, I have observed recently that it is by no means only in small vessels that the blood remains fluid after death. If blood be retained within the jugular vein of a horse or ox by the application of ligatures, either before or after the animal has been struck with the poleaxe, it will often continue fluid, but coagulable, in that vessel, which is upwards of an inch in diameter, for twenty-four or even forty-eight hours after it has been removed from the body. I say often, but not always. The jugular vein seems to be in that intermediate condition, between the heart and the small vessels, in which it is uncertain whether it will retain its vital properties for many hours, or will lose them in the course of one hour or so. Unfortunately for my present purpose, it happens that in this jugular vein, removed from an ox six hours ago, coagulation has already commenced, as I can ascertain by squeezing the vessel between my fingers. But now that I lay open the vessel, you observe that the chief mass of its contained blood is still fluid, and we shall at all events have an opportunity of seeing that what is now fluid will in a short time be coagulated. It is an interesting circumstance with reference to the question which we are now considering, that the coagulation always begins in contact with the vein, indicating that it is not the wall of the vessel that keeps the blood fluid, but that, on the contrary, the wall of the vessel, when deprived of vital properties, makes the blood coagulate.

The observation of the persistent fluidity of the blood in these large vessels furnished the opportunity of making a very satisfactory experiment, which I hoped to have exhibited before the Society; but as there was some clot in the vein, I did not think fit to run the risk of failure. The experiment is performed in the following way. A piece of steel wire is wound spirally round one of the veins in its turgid condition, and with a needle and thread the coats of the vessel are stitched here and there to the wire, care being taken to avoid puncturing the lining membrane, and thus the vessel is converted into a rigid cup. Two such cups being prepared, and the lining membrane of the vein being everted at the orifice of each so as to avoid contact of the blood with any injured tissue, I found that, after pouring blood to and fro through the air in a small stream from one venous receptacle into the other half a dozen times, and closing the orifice of the receptacle to prevent drying, the blood was still more or less completely fluid after the lapse of eight or ten hours. On the other hand, if a fine sewing-needle is pushed through the wall of an unopened vessel so that its end may lie in the blood, it is found on examination, after a certain time has elapsed, that the needle is surrounded with an encrusting clot. It is scarcely necessary to point out how entirely the ammonia theory and the oxygen theory, as well as that of rest, fail to account for facts like these.

While the blood may remain fluid for forty-eight hours in the jugular vein of a horse or an ox, it coagulates soon after death in the heart of very small animals, such as mice; so that it is obvious that the continuance of fluidity in small vessels is not due to their small size.

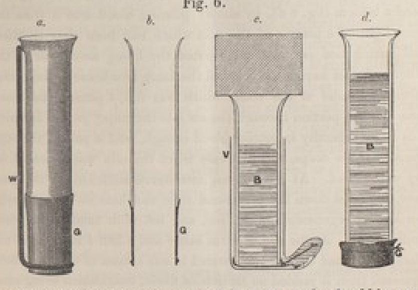
It is a very curious question, What is the cause of the blood remaining so much longer fluid in some vessels than in others? I believe that we must accept it simply as an ultimate fact, that just as the brain loses its vital properties earlier than the ganglia of the heart, so the heart and principal vascular trunks lose theirs sooner than the smaller vessels of the viscera, or than more superficial vessels, be they large or small. We can see a final cause for this, so to speak. So long as the heart is acting, circulation will be sure to go on in the heart and principal trunks; whereas, on the contrary, the more superficial parts are liable to temporary causes of stagnation, and occasionally to what amounts to practical severance from vascular and nervous connexion with the rest of the body; and it is, so to speak, of great importance that the blood should not coagulate so speedily in the vessels of a limb thus circumstanced as it does in the heart after it has ceased to beat. Were it not for this provision, the surgeon would be unable to apply a tourniquet without fear of coagulation occurring in the vessels of the limb. As an illustration of the importance of a knowledge of these facts, I may mention a case that once occurred in my own practice. I was asked by a surgeon in a country district to amputate an arm which he despaired of. The brachial artery had been wounded, as well as veins and nerves, and at last, being foiled with the hemorrhage, he wound a long bandage round the limb at the seat of the wound as tightly as he possibly could. It had been in this condition with the bandage thus applied for forty-eight hours when I reached the patient; and the limb had all the appearance of being dead. It was perfectly cold, and any colour which it had was of a livid tint. But having been lately engaged in some of the experiments which I have been describing, and having thus become much impressed with the persistent vitality of the tissues and the concomitant fluidity of the blood, I determined to give the limb a chance by tying the brachial artery. Before I left the patient's house he had already a pulse at the wrist, and I afterwards had the satisfaction of hearing that the arm had proved a useful one.

One of the two arguments in favour of activity on the part of the vessels as a cause of the fluidity of the blood having been completely disposed of, let us now consider the other, viz. the rapid coagulation of blood shed into a basin, appearing at first sight to imply a spontaneous tendency of the blood to coagulate, such as would have to be counteracted by the vessels. This also has proved fallacious.

In the first place it appears that the coagulation, after all, does not go on in a basin so suddenly as one would at first sight suppose, but always commences in contact with the foreign solid. When blood has been shed into a glass jar, if, on the first appearance of a film at the surface, you introduce a mounted needle curved at the end between the blood and the side of the glass and make a slight rotatory movement of the handle, you see through the glass the point of the needle detaching a layer of clot whatever part you may examine. The process of coagulation having thus commenced in contact with the surface of the vessel into which the blood is shed, may under favourable circumstances be ascertained to travel inwards, like advancing crystallization, towards the centre of the mass. It appears, however, that this extension of the coagulating process would not take place had not the blood been prepared for the change by contact, during the process of shedding, with the injured orifice of the blood-vessel and with the surface of the receptacle. I have only very recently become acquainted with the remarkable subtlety of the influence exerted upon blood by ordinary solids. I was long since struck with the fact, that if I introduced the point of an ordinary sewing-needle through the wall of a vein in a sheep's foot and left it for twelve hours undisturbed, the clot was still confined to a crust round the point of the needle, implying that coagulum has only a very limited power of extension. I thought, therefore, that by proper management it might be possible to keep blood fluid in a vessel of ordinary solid matter lined with clot. But various attempts made with this object failed entirely, till I lately adopted the following expedient. Having opened the distal end of an ox's jugular vein containing blood and held in the vertical position, taking care to avoid contact of any of the blood with the wounded edge of the vessel, I slipped steadily down into it a cylindrical tube of thin glass, somewhat smaller in diameter than the vein, open at both ends, and with the lower edge ground smooth in order that it might pass readily over the lining membrane, and so disturb the blood as little as possible by its introduction, and influence only the circumferential parts of its contents. The tube was then kept pressed down vertically upon the bottom of the vein by a weight, in a room as free as possible from vibration, and I found on examining it at the end of twelve hours that the clot was a tubular one, consisting of a crust about one-eighth of an inch thick next the glass and the part exposed to the air, but containing in its interior fluid and rapidly coagulable blood. In another such experiment, continued for twenty-fours, though the crust of clot was thicker, the central part still furnished coagulable blood.

But it may perhaps be argued by those who say that the blood-vessels are active in maintaining fluidity, that the small portion of the vein covering the end of the tube was acting upon the blood, which certainly was fluid where in contact with it, the clot being in the form of a tube open at the lower end. To guard against such an objection I made the following experiment:—I extended a tube like that above described by means of thin sheet gutta percha, G (fig. 6 *a*),

Fig. 6.



contriving that the internal surface of the gutta percha should be perfectly continuous with that of the glass tube as represented in section in fig. 6 *b*. The lower part of the gutta-percha tissue was strengthened by a ring of soft flexible wire such as is used by veterinary surgeons for sutures, and the wire W was also extended upwards to the top of the glass so as to maintain the rigidity of the gutta-percha portion during its introduction into a vein, but at the same time, from its softness, permit the gutta-percha part to be bent at a right angle after it had been introduced, and so close the orifice of the glass tube with ordinary solid matter. In fig. 6 *c* the tube is represented pressed down by a weight in a vein V, with blood B in the glass portion, while the gutta-percha part closes it below. At the same time I performed a comparative experiment, to which I would invite particular attention, although I am sorry at this late hour to occupy the attention of the Society so long. I tied a thin piece of gutta-percha tissue over the lower end of a similar glass tube, and simply poured blood into it from the jugular vein of an ox. I wished to compare the condition of blood which had been simply poured into a tube, with blood which had been introduced without any disturbance of its central parts. But in order to make the experiment a fair one, as it might be said that the blood poured from the vein had been more exposed to the air than that into which the tube was slipped, I proceeded in the following way:—I obtained a long vein containing plenty of blood, and having first filled the second tube, with the gutta-percha bottom (fig. 6 *d*), by simply pouring blood into it from the vein, I cut off a portion of the vein which had been thus emptied, and having tied one end and everted the lining membrane of the other end, and having also everted the lining membrane of the orifice of the remainder of the vessel which was full, I poured the blood from the full portion through the air into the empty part. In doing this I had difficulty in getting blood enough, and it passed through the air in slow drops, and that only when the vein was squeezed by my warm hand. At last, having introduced sufficient for the purpose, I slipped down the compound tube and bent its gutta-percha portion, as represented in fig. 6 *c*, and left both tubes for a while undisturbed. At the end of three hours and a half I found that the blood which had been simply poured in was a mass of clot, and fluid squeezed from it yielded no threads of fibrin, coagulation being complete. How long it had been so I do not know. I did not examine the other blood until seven hours and three quarters had expired, and then found that, just as in the cases where a simple glass tube was introduced, the clot was tubular, and the chief part of the blood was still fluid in its interior, the only difference being that in this case the clot formed a complete capsule, being continued over the gutta percha instead of being deficient below, as it was when the vein closed the end of the tube. Now if we consider the two parts of this comparative experiment, we see that the receptacles in which the blood was ultimately contained were precisely similar in the two cases, viz. glass tubes closed below with gutta percha; and that the blood which was simply poured into the tube was much less exposed to the air than the other, and also was not subjected, like it, to elevation of temperature, a circumstance which promotes coagulation; but yet this blood became completely coagulated in a comparatively short time, whereas the other after a much longer time was coagulated only in a layer in contact with the foreign solid. But in the latter case the blood had been so introduced as to avoid direct action of ordinary matter on any but the circumferential parts of it; whereas in the former, though poured quickly, it had run down the side of the glass, and as a consequence of this almost momentary contact with the foreign solid, the central parts, like the circumferential, underwent the process of coagulation.

Mysterious as this subtle agency of ordinary solids must appear, its occurrence is thus matter of experimental demonstration, and by it the coagulation of blood shed into a basin is accounted for; while it is also shown conclusively from this experiment that the blood, as it exists within the vessels, has no spontaneous tendency to coagulate, and therefore that the notion of any action on the part of the blood-vessels to prevent coagulation is entirely out of the question. The peculiarity of the living vessels consists not in any such action upon the blood, but in the circumstance, remarkable indeed as it is, that their lining membrane, when in a state of health, is entirely negative in its relation to coagulation, and fails to cause that molecular disturbance or, if we may so speak, catalytic action which is produced upon the blood by all ordinary matter.

I afterwards found that the simplest method of maintaining blood fluid in a vessel composed entirely of ordinary matter was to employ a glass tube similar to those above described, except that its upper end was closed by a cork perforated by a narrow tube terminating in a piece of vulcanized india-rubber tubing that could be closed by a clamp. This tube was slipped down into a vein till the blood, having filled it completely, showed itself at the orifice of the india-rubber tubing, to which the clamp was then applied. The whole apparatus was now quickly inverted, and the vein was drawn off from over the mouth of the tube, which was then covered with gutta-percha tissue to prevent evaporation. After the inverted tube had been kept undisturbed in the vertical position for nineteen hours and three quarters, coagulable blood was obtained from the interior of the clot.

We have seen that a clot has but very slight tendency to induce coagulation in its vicinity unless the blood has been acted on by an ordinary solid; and it is probable that with perfectly healthy blood it would be unable to produce such an effect at all. This appears to me to be very interesting physiologically, but especially so with reference to pathology. I must not go now fully into the circumstances that lead me to it; but I may express the opinion I have formed, that clot must be regarded as living tissue in its relation to the blood. It is no doubt a very peculiar form of tissue, in this respect, that it is soft, easily lacerable, and easily impaired in its vital properties. If disturbed, as in an aneurism, it will readily be brought into that condition which leads to the deposition of more clot; but if undisturbed, it not only fails to induce further coagulation, but seems to undergo spontaneous organization. I have seen a clot in the right side of the heart, and extending into the pulmonary artery and its branches, unconnected with the lining membrane of auricle or ventricle or with the pulmonary artery except at one small spot where it had a slight adhesion, developed into perfect fibrous tissue by virtue, it would appear, of its own inherent properties. Another observation which I once made, and which then completely puzzled me, now seems capable of explanation. In laying open the blood-vessels of a dead body, I observed in many of the veins a delicate white lace-like tissue which evidently must have been formed from a clot. This I now believe to have had the same relation to the coagulum as the flimsy cellular tissue of old adhesions has to lymph.

It may not be altogether superfluous to mention some other facts illustrative of the active influence of ordinary matter in promoting coagulation, and the negative character of the lining membrane of the vessels. I find that a needle introduced into one of the veins of the foot of a sheep for a much shorter time than is necessary to produce the first appearance of the actual deposit of fibrin upon it, leads after a while to coagulation where the needle had lain—in other words, that a foreign solid, by a short period of action on the blood, brings about a change that results in coagulation, though the blood still lies in the living vessels. I have also ascertained that after blood has been made to coagulate in a particular vessel by introducing a needle into it, if the coagulum as well as needle is removed, and more fluid blood is allowed to pass in, this blood remains fluid for an indefinite period, showing that the needle had not impaired the properties of the vessel by its presence; so that the previous coagulation

must be attributed not to any loss of power in the vein, but simply to the action of the foreign solid.

In seeking for an analogy to this remarkable effect of ordinary solids upon the blood, we are naturally led to the beautiful observations of Professor Graham, lately published in the Philosophical Transactions. He has there shown what insignificant causes are often sufficient to induce a change from the fluid or soluble to the "pectous," or insoluble condition of "colloidal" forms of matter. Indeed Mr. Graham has himself alluded to the coagulation of fibrin as being probably an example of such a transition.

There is, however, another remarkable circumstance that must be taken into consideration, of which I myself have been only recently aware, and which may be new to several Fellows of the Society; and that is, that in spite of the influence of an ordinary solid the liquor sanguinis is not capable of coagulating *per se*. It was observed many years ago by my colleague, Professor Andrew Buchanan, of Glasgow, that the fluid of a hydrocele, generally regarded as mere serum, coagulated firmly if a little coagulum of blood diffused in water was added to it—an effect which he was disposed to attribute to the agency of the white corpuscles*. I repeated Dr. Andrew Buchanan's observations last year, and satisfied myself first that the diffused clot did not act simply by providing solid particles to serve as starting-points for the coagulating process. I tried various different materials in a finely divided state, and found that none of them, except blood, produced the slightest effect. But I found that if a mixture of serum and red corpuscles from a clot was added to some of this hydrocele-fluid, it was soon converted into a firm solid mass. If a small quantity of the serum and corpuscles was dropped into the fluid and allowed to subside without stirring, coagulation rapidly took place in those parts where the red corpuscles lay, while other parts of the fluid remained for a long time uncoagulated. This seemed to indicate that the red corpuscles had a special virtue in inducing the change. I confess, however, that till very lately I was inclined to suppose that in the hydrocele-fluid the fibrin must be in some peculiar spurious form. We know that the buffy coat of the horse's blood coagulates in a glass without addition of clot, and we know that lymph coagulates; so that I did not doubt

* Proceedings of the Glasgow Philosophical Society, February 19, 1845.

that liquor sanguinis would always undergo the change when influenced by ordinary matter. But an observation which I made not many days ago, shows that this was a mistake. I obtained the jugular vein of a horse, and having kept it for a while in a vertical position till I could see through its transparent coats that the red corpuscles had fallen from the upper part, I removed all bloody tissue from that part of the vein, and punctured it so as to let out the liquor sanguinis into a glass. Finding after eighteen minutes that the liquid had not begun to coagulate, I added a drop of serum and corpuscles to a portion of it, and within seven minutes there was a clot wherever the corpuscles lay, whereas the rest of the fluid was still very imperfectly coagulated after another half hour had elapsed. That the liquor sanguinis to which no addition had been made coagulated at all, was sufficiently explained by microscopic investigation, which showed not only abundant white corpuscles, but also several isolated red ones that had not subsided. This observation was made three hours after the death of the horse, but I obtained essentially similar results on repeating the experiment in another horse an hour after death; so that there can be no doubt whatever that the fibrin was in the same condition as it is in the blood-vessels of a living animal. The observation appears also particularly satisfactory on this account, that the liquor sanguinis was not separated from the corpuscles by any process of transudation through the walls of the blood-vessels, which might be conceived to involve retention of some constituent of the liquid, which, though in solution, might be unable to pass through their pores, but simply by the subsidence of the corpuscles, which must have left all the materials of the liquor sanguinis behind them. Hence it is proved beyond question that if the liquor sanguinis could be separated completely from the blood-corpuscles, it would resemble the fluid of hydrocele in being incapable of coagulation when shed into a cup.

Now this struck me as a very satisfactory and beautiful truth, inasmuch as it clears away all the old mystery of the distinction between inflammatory exudations and dropsical effusions. Dropsical effusions, exhibiting little disposition to coagulate, have been supposed to consist almost exclusively of serum, and the exudation of the entire liquor sanguinis has been regarded as the special characteristic of inflammation; and very unsatisfactory theories have been

put forward by ingenious pathologists to account for this difference. But it now appears that a dropsical effusion, like that of hydrocele, is undistinguishable from pure liquor sanguinis.

Various dropsical effusions have been lately investigated with reference to their coagulability on the addition of blood-corpuscles, by Dr. Schmidt of Dorpat, who finds that while they differ from one another in the amount of water they contain (just as is the case with serum filtered artificially through animal membranes under different degrees of pressure), yet they are all but universally coagulable. Schmidt has also carried the investigation further. He has found that by chemical means he can extract from the red corpuscles a soluble material which, when added to these exudations, leads to coagulation. In other words, he shows that the corpuscles do not act as living cells, but by virtue of a chemical material which they contain, which can be used in the state of solution, free from any solid particles whatever. He found also that the aqueous humour made a dropsical effusion coagulate, and that the same effect was produced by a material extracted from the non-vascular part of the cornea. Hence he regards the blood-corpuscles as only resembling other forms of tissue in possessing this property. These observations are extremely interesting, if trustworthy; and that they are so, I do not at all doubt; but having only read Schmidt's papers within the last day or two, I have not yet had opportunity of verifying his statements*.

It remains to be ascertained what share the material derived from the corpuscles has in the composition of the fibrin. Schmidt inclines to the opinion that the fibrin is probably composed, in about equal proportions, of a substance furnished by them and one present in the liquor sanguinis. If this be true, the action of an ordinary solid in determining the union of the components of the fibrin may be compared to the operation of spongy platinum in promoting the combination of oxygen and hydrogen.

* Since this lecture was delivered I have verified an important observation made by Schmidt, viz. that a given amount of corpuscles causes complete coagulation of only a limited quantity of hydrocele-fluid. From this he draws the inference, that the action of the corpuscles cannot be of the nature of fermentation—the coagulative efficacy of the corpuscles being not continued indefinitely, but becoming exhausted in the process of coagulation. For Schmidt's papers, see Archiv für Anat. Phys. &c. 1861 and 1862.

It may be asked, How comes it that when the blood of a horse is shed into a cup, the buffy layer coagulates as rapidly, or nearly so, as the lower parts rich in corpuscles?

This is indeed a question well worthy of careful study. We know that the liquor sanguinis left by the subsidence of the red corpuscles within a healthy vein is incapable of coagulating when shed, except in a slow manner, which is accounted for by the corpuscles that remain behind in it. Hence it appears that when the blood as a whole is shed into a glass, the agency of the ordinary solid leads the corpuscles to communicate to the liquor sanguinis, before they subside, a material or at least an influence which confers upon it a disposition to coagulate, though it still remains fluid for some time after they have left it. Just as we have seen that a very short time of action of the ordinary solid upon the blood as a whole is sufficient to give rise to coagulation, so we now see that, provided an ordinary solid be in operation, the presence of the corpuscles for but a little while is enough to make the liquor sanguinis spontaneously coagulable, though not immediately solidified. We shall see, before concluding, an illustration of the importance of this fact to pathology.

It remains to be added, that serous membranes resemble the lining membrane of the blood-vessels in their relations to the blood, as is implied by John Hunter's observation that blood, which had lain for several days in a hydrocele, coagulated when let out. The same thing is well illustrated in a frog prepared like this which I now exhibit. About four hours ago, a knife having been passed between the brain and cord to deprive the creature of voluntary motion in the limbs and trunk, the peritoneal cavity was laid open in the middle line, and its edges being kept raised and drawn aside by pins, I seized the apex of the ventricle of the heart with forceps and removed it with scissors. In a short time the whole of the animal's blood was in the peritoneum, and it may be seen that it is still fluid in spite of this long-continued exposure. When I first performed the experiment three years and a half ago, the weather being cool (about 45° Fahr.) and a piece of damp lint being kept suspended above the frog to prevent evaporation and access of dust, I found that the blood remained fluid in the peritoneal cavity for four days, except a thin film on the surface, and a crust of clot on the wounded part of the heart; but a piece of clean glass placed in the blood in the

peritoneum became speedily coated with coagulum. Here, it will be observed, not merely the liquor sanguinis, but the corpuscles also were present in the serous cavity, yet no coagulation took place in contact with its walls.

I think it probable, though not yet proved, that all living tissues have these properties with reference to the blood. We know that the interstices of the cellular tissue contain coagulable fluid, and I have seen anasarcous liquid coagulate after emission; but this indeed may possibly have been merely liquor sanguinis, coagulating in consequence of slight admixture of blood-corpuscles from the wounds made in obtaining it.

Looking now at the principal results which we have arrived at, it must, in the first place, be admitted that the ammonia theory is to be discarded as entirely fallacious. The fact that this theory is exceedingly plausible, and has been supported by many ingenious arguments and experiments, is of course no reason why we should retain it if unsound. On the contrary, the more specious it is the more necessary is it that it should be effectually cleared away; for it mystifies the subject of coagulation most seriously; and I may say, for my own part, that it has cost me an amount of experimental labour of which the illustrations brought forward this evening convey but little idea. Still these have been, I trust, sufficient to show that the coagulation of the blood is in no degree connected with the evolution of ammonia, any more than with the influence of oxygen or of rest. The real cause of the coagulation of the blood, when shed from the body, is the influence exerted upon it by ordinary matter, the contact of which for a very brief period effects a change in the blood, inducing a mutual reaction between its solid and fluid constituents, in which the corpuscles impart to the liquor sanguinis a disposition to coagulate. This reaction is probably simply chemical in its nature; yet its product, the fibrin, when mixed with blood-corpuscles in the form of an undisturbed coagulum, resembles healthy living tissues in being incapable of that catalytic action upon the blood which is effected by all ordinary solids, and also by the tissues themselves when deprived of their vital properties.

These principles have, of course, very extensive applications to the study of disease; but I must content myself with alluding very briefly to inflammation, the most important of all pathological conditions.

If we inquire what is the great peculiarity of inflamed parts in relation to the blood as examined by the naked eye, we see that it consists in a tendency to induce coagulation in their vicinity—implying, according to the conclusions just stated, that the affected tissues have lost for the time being their vital properties, and comport themselves like ordinary solids. Thus, when an artery or vein is inflamed, coagulation occurs upon its interior, in spite of the current of blood, precisely as would take place if it had been artificially deprived of its vital properties. On one occasion I simulated the characteristic adherent clot of Phlebitis by treating the jugular vein of a living sheep with caustic ammonia, and then allowing the circulation to go on through the vessel for a while, when, on slitting it up, I found its lining membrane studded with grains of pink fibrin which could be detached only by scraping firmly with the edge of a knife. Again, comparing an inflammatory exudation into the pericardium or into the interstices of the cellular tissue with dropsical effusions into the same situations, we are struck with the fact that, while the liquor sanguinis effused in dropsy remains fluid, the inflammatory product coagulates. Now we know that in intense inflammation the capillaries are choked more or less with accumulated blood-corpuscles, which must cause great increase in the pressure of the blood upon their walls; and from what we know of the effect of venous obstruction in causing dropsical effusion of liquor sanguinis through increased pressure, we are sure that we have in the inflammatory state the physical conditions for a similar transudation of fluid through the walls of the capillaries. And the natural interpretation of the difference in the two cases as regards coagulation seems to be, that whereas in dropsy the fluid is forced through the pores of healthy vessels, in inflammation the capillary parietes have lost their healthy condition, and act like ordinary matter; so that the liquor sanguinis, having been subjected, immediately before effusion, to the combined influence of the injured tissue and the blood-corpuscles, has acquired a disposition to coagulate, just like the buffy coat of horses' blood shed into a glass, or like the frog's liquor sanguinis filtered by Müller from its corpuscles, the injured vessels acting upon the blood like the filter.

This view of the condition of intensely inflamed parts is exactly that to which I was led some years ago by a microscopic investigation, the results of which were detailed in a paper* that received the honour of a place in the Philosophical Transactions. It was there shown, as I think I may venture to say, that the tissues generally are capable of being reduced under the action of irritants to a state quite distinct from death, but in which they are nevertheless temporarily deprived of all vital power, and that inflammatory congestion is due to the blood-corpuscles acquiring adhesiveness such as they have outside the body, in consequence of the irritated tissues acting towards them like ordinary solids.

I cannot avoid expressing my satisfaction that this inquiry into the coagulation of the blood has furnished independent confirmation of my previous conclusions regarding the nature of inflammation.

VARIOLA OVINA, SHEEP'S SMALL-POX; OR THE LAWS OF CONTAGIOUS EPIDEMICS ILLUSTRATED BY AN EXPERIMENTAL TYPE.

"L'épidémie est l'effet et non la cause de la contagion."—*Gendron de l'Eure.*

"Veluti in speculo."

In complying with the request of the Association to deliver the Address in Medicine for the present year, I shall follow the example of my immediate predecessors, and confine myself to a single theme. For reasons which will, probably, be readily understood by many who hear me, the particular theme I have chosen is one bearing on the subject of epidemics. There is no need in an assembly like this to dilate on its importance.

There are few secrets in nature which it is of greater moment to man to penetrate, than that of the rise, spread, and deadly power of these terrible scourges. In the aggregate, take the world through, they cause more untimely deaths, more sickness, more sorrow, more loss of labour, bodily and mental, than any of the other ills to which humanity is subject. They attack us in the cradle, they pursue us through youth and manhood; in old age, they still linger about our path. They are among our greatest hindrances in the battle of life, even when they do not end life itself by a sudden and invisible stroke. Every year, in all lands, a vast hecatomb of men prematurely gathered to the grave bears witness to their power.

To rescue mankind from the grasp of epidemic disorders should, therefore, be the settled, as it must always be the highest, ambition of our art. With Jenner's immortal discovery before us to show that such an ambition is neither presumptuous nor vain, the growing attention paid, of late years, to this great subject is easily understood.

In England, as is well known, a society has been established for its sole and special cultivation. In the annual reports of the French Academy of Medicine, epidemics have long occupied a large space. In Germany, as, indeed, in all countries in which medicine is studied as a science, they are fast rising as objects of inquiry into the prominence which their importance deserves.

Unfortunately, the advance of knowledge bears, as yet, but scant proportion to the efforts spent in its pursuit. This, as it seems to me, may be mainly traced to two causes; first, to an exaggerated estimate of the difficulties of the subject; and secondly, to want of clear views as to the method to be followed in its investigation. Authors have occupied themselves far too much in dwelling on the inscrutable nature of epidemic poisons, and in accumulating epithets to signify the hopelessness of attempts to discover the laws of their action. This practice hinders the advance of science, by discouraging inquiry; and, still more fatally, by begetting a prejudice against precise views, on the plea that such views are unattainable, and hence cannot be in accordance with truth.

The difficulties of the subject are obvious. The material causes of epidemics are invisible; and the laws which govern invisible things must needs be hard to make out. But that they may be perfectly made out is clear from this, that the invisible powers of nature, such as gravitation, for instance, are the very powers of which our knowledge is the most sure and precise.

On the other hand, the problem of the epidemiologist has in it at least one element of simplicity which is denied to the student of other diseases; namely, that its chief concern is with the history of a single cause. His principal task is to trace, in each case, the biography, if I may so speak, of a single species. The method most in vogue in inquiries of this kind, as hitherto conducted, is to accumulate a mass of statistical details—meteorological, physiological, topographical, and other—relating to the particular epidemic disease which may happen to be in question, often with the most impartial indifference as to whether these details establish anything of importance, or not.

If we had not experience to appeal to in proof of the assertion, it would not be difficult to show, on

philosophical grounds, that this mode of proceeding must necessarily be extremely barren of results. Evidence so collected is, no doubt, of value; but chiefly as furnishing data for the real discoverer to work upon.

Statistics afford much important information on epidemics; but it is all of a general kind. The really vital questions they leave almost untouched. Neither on the mode of being of the morbific agent without the body, nor on its mode of action within, do they throw any but a dim and distant light. Happily, there is another principle at our service which is of far greater promise.

The chief difficulty of the inquiry arises, as I said before, from the fact, that its subjects are, for the most part, not objects of sense, but only known by their effects. In the face of this difficulty, the only sure way of proceeding is to begin with the study of those types which in their mode of action offer something tangible for the observer to lay hold of; something that may enable him to bring the diffuse, vagrant, and impalpable thing into the witness-box—if I may use such an expression—and to put to it definite questions with some chance of definite answers.

What we want is some clue, however slender, to guide us through the obscurity in which the truth lies hid. Now, exactly such a clue is found in that most remarkable of properties; the power which certain epidemic disorders possess of spreading by contagion. In the act of contagion, we are brought into direct relation with the epidemic poison at one very important phase of its existence. Before this address is concluded, I hope to make it clear that in the conditions which often attach to this act, there are data which will carry us very deep into the secrets we most desire to know.

The first position I would take, therefore, is, that if we wish to obtain clear views on the subject of epidemics generally, our surest plan is to begin with the study of the contagious group.

The next position speaks for itself. It is, that of this group we should select those which, from peculiarities in the mode of evolution of the virus, admit of being propagated artificially; which offer, in other words, the incomparable advantage of being studied experimentally. I say "incomparable", because, however arduous the problem, the whole history of science shows that, where once this all-potent method of putting questions to nature can be used with effect, all difficulties go down before it.

If we were asked to define what other conditions we would most desire, in order to make our task the more easy, our answer would be, that all the sufferers should be under our own eye; that their incomings and outgoings and intercourse with one another should be known to us; or, better still, should be determined by our own will. It will be seen at once that, taken together, these conditions are not to be met with in human life. They are only to be found, in fact, in the case of the domestic animals.†

Since we last met, the West of England has witnessed an epidemic among one of the chief of these, in which all the conditions just enumerated were fulfilled to the letter, with one more added, almost equal in value to all the rest. The pest, in the case to which I refer, was entirely new to the country in which it raged. For a century, at least, nothing has occurred in this island more deeply instructive to the epidemiologist than the remarkable outbreak of the disease popularly known by the name of small-pox, which ravaged the Wiltshire flocks last autumn. For this, I need scarcely say, is the event of which I speak.

On the 13th September, 1862, while the disorder was still rife, I visited the diseased flocks, and enjoyed the great privilege of studying the malady from the life, under the able guidance of Professor Simonds. I beg to take this opportunity of returning publicly to that gentleman, my best thanks for the great kindness he showed to me on that occasion.‡

As there were still, at that time, some six or eight hundred patients in all stages of the disorder, it was not difficult, under such able teaching, to become acquainted, even in the short compass of a single day, with its leading characteristics.

† There can be no more striking proof of the little way the philosophy of this branch of inquiry has made among us than the small space given to epizootics by the professed epidemiologist. The only scientific accounts of them must be sought for in the works of veterinarians. With the exception of our distinguished associate Mr. Ceely, of Sir H. Holland, and of one or two others, the allusions of English physicians to the diseases of animals are only remarkable as betraying their ignorance of the whole subject.

‡ With the liberality characteristic of the true man of science, Professor Simonds communicated to me at once all he knew of the history of the outbreak, and at the cost of infinite pains demonstrated to me all the leading features of the disorder.

Awaiting the fuller and more accurate record of this outbreak, which I trust we are yet to have, from one or both of the eminent men who advised the government in the emergency, I will ask your permission, in default of a better topic, to occupy the remainder of the short hour allotted to these addresses in laying before you the more salient points of the information I then acquired, together with some reflections which have been since suggested to me by the study of the disease in veterinary works.† In doing this, it is hardly necessary to observe that I shall not treat the subject in its bearing on agricultural interests, but in its purely scientific and medical aspects.‡

After what I have already said, no apology will be needed for thus bringing to the notice of gentlemen whose lives are passed in watching the diseases of men, a disease which is peculiar to one of the lower animals. The very name which this distemper bears —*small-pox* in sheep—attests its human interest, as the series of relations which suggested this name, attests the entire applicability of any inferences drawn from it to the great and important group of which human small-pox is the type. In passing under review the phenomena of this outbreak, we shall, in fact, find ourselves reviewing the phenomena—and I may add discussing the questions—which most press upon the mind in regard to the contagious fevers of our own race.

As the disease itself, except as a matter of common report, is probably new to most of my hearers, a few preliminary words as to its history and characters may not be out of place.

As to its history in past time, but little is known. Its first origin, like that of human small-pox, is lost in the mist of ages, and hidden by the same impenetrable veil which hides the first origin of all other

† The sources from which what follows is mostly drawn, are—1. Information acquired in my visit to Allington; 2. Professor Simonds' masterly monograph on *Variola Ovina*; 3. Hurtrel d'Arboval's admirable articles on "Clavelée", "Claveau", "Clavelisation", "Vaccination", and "Vaccine", in the *Dictionnaire de Médecine Vétérinaire*; Professor Trousseau's *Clinique Médicale*; and various articles on the Wilts outbreak, by Professors Simonds and Gamgee, in the *Veterinarian* and the *Edinburgh Veterinary Review*.

‡ For this reason, I shall make no reference, for instance, to the animated discussion which has sprung up as to the way in which these interests were affected by the practice of inoculation in the infected district.

created things. Like human small-pox—on what grounds I do not exactly know—it is supposed to have first come into being, in the great, mysterious, maternal East. In Europe, it can be traced distinctly back only to the sixteenth century. The first clear account of the disease in any European tongue, is to be found, it is said—for I do not speak of my own knowledge—in the writings of Rabelais. From an early period it has covered a very wide area in the Old World. India and Africa have been infested by it from time immemorial. America still lives in happy ignorance of this ovine plague; but there is no province in continental Europe whose flocks have not suffered severely from it. In Italy and Spain, the *clavelée*, as the French call the malady, is the one great dread of the flock-master. In Bessarabia, Austria, Prussia, Holstein, Denmark, and Holland, it is a standing scourge. The whole north of France is the scene of frequent epidemics of it. But, until some seventeen years ago—with, perhaps, one doubtful exception—the disease had remained entirely unknown in this country. Up to that date, the shepherd of Picardy, watching with dismay his dying and plague-stricken lambs, covered with the well known blains, might look with envious eyes across the narrow channel, and almost see on a clear day, browsing on the white cliffs of the sea-girt island opposite, countless flocks that from all time had lived in virgin immunity from the pest at his feet.

"The circumstance is easy to explain," says Hurtrel d'Arboval, "if we reflect that in almost all cases the disease is the result of contagion, and if we consider the severe measures enforced in England against the importation of foreign sheep into that island." (*Dictionnaire de Médecine Vétérinaire*, article '*Clavelée*'.)

The time had now come when this long-standing contrast was to cease. With the triumph of free-trade, the measures referred to by the French veterinarian were relaxed, and foreign sheep were admitted without stint. Before the year 1847, the whole number imported amounted only to a few hundreds, selected, too, for the most part, by the English agriculturist for some special merits, with all the care to ensure freedom from disease which such a proceeding implies. A few years afterwards, the number had grown to several hundred thousand; and the sheep, instead of being picked out from the foreign fold by the English buyer,

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were sent wholesale to the English market as an article of common commerce by the foreign flock-master. Unfortunately, the change fell upon an evil time. Quarantine and all other measures intended to prevent the introduction of disease from abroad had fallen into discredit, if not into disuse. Contagion, as a cause of epidemic disease, had come to be looked upon as a thing of small account. Worse still, the strange and fatal delusion had got hold of men's minds, that the specific poisons of specific contagious disorders may be bred for the nonce, anywhere, out of filth, organic impurites, or what not. It seemed to be a waste of power to be taking precautions against the importation from without of what might turn up any day as a home product.

Want of acquaintance with the epidemic and contagious maladies of foreign live-stock had, no doubt, its share, also, in allaying the vigilance the occasion so much needed. And so it happened that the barriers were thrown down, without those precautions being taken which alone could render the proceeding safe. The result has been that, within the short space of sixteen years, England, which for the whole thousand years before had never known this plague, has thrice seen it commit great havoc in her flocks. Thus have we become indebted to the British government for events disastrous to agriculture; but, could they be made to tell their whole tale, of the utmost value to science.

On the characters of the disease itself I need not dwell long. The name it bears enables me to dispense with any lengthened description. What human small-pox is to man, that precisely, and in all ways, is this disease to the sheep. It is a contagious eruptive fever, which spreads in what is called the natural way, but is susceptible also of being inoculated. Like small-pox—and, I may add, like all the other contagious fevers—it unites the two fundamental characteristics of having a period of incubation, and of occurring but once in life.†

By comparing the drawings here exhibited, you may see how close and striking is the outward resemblance of the eruption in the two diseases. Its distri-

† For the sake of simplicity, the word "contagion" is used throughout this essay as signifying the communication of a specific disease, through whatever medium, by specific germs thrown off by subjects already suffering from it.

bution in each is exactly alike. The skin, the nostrils and fauces, and the upper part of the respiratory tract, are its common seat in both. In both, the mode of evolution is the same.

The ovine eruption begins under the form of papulæ, confluent or discrete, culminating in a vesicle which is often marked by a central depression, and is filled by lymph, which, at first translucent, ends in becoming opaque. It forms crusts, which fall away by a slow desquamation. It leaves pits. Not rarely falling upon the eye, it leads to blindness. It is a frequent cause of abortion; the dropped lambs being, in this case, often covered with variolous pustules.

There is the same parallelism between the two in the constitutional disturbance. Ovine small-pox is ushered in by high fever and great general distress, which are relieved for a time by the eruption, to recur again under the typhoid form in the suppurative stage. It is often attended by bloody urine and extensive ecchymoses. It kills in the same way as its human antitype.

If you examine the drawings minutely, you will observe some marked differences. The papulæ, for instance, are much broader in the sheep, varying in breadth from that of a fourpenny-piece to that of a shilling: having the appearance of large flat warts occupying the whole thickness of the skin, and imbedded in it. Other points of difference might be noted if need were, and if time allowed. It is rather, however, with the points of resemblance than with those of difference that we are here concerned. It is sufficient to our present purpose to know that this is a typical member of the great group of contagious fevers, which are propagated by a specific poison, which have a period of incubation, which multiply as they go, and which occur but once in life.

The farm in which this remarkable disease suddenly made its appearance in June last year is situated in the parish of Allington, about seven miles north-east of Devizes, and at the foot of the range of chalk-hills known as the Beckingham Downs. In gazing upon that fine, open, breezy country, the idea of pestilence is the last that would ever occur to the mind. The sheep first attacked were the property of Mr. Joseph Parry, a gentleman noted for the pure breed and healthy character of his flock.

As far as there is evidence to show, the outbreak itself

began, as such outbreaks generally do, with a single case. Towards the latter end of June, Mr. Parry, riding alongside one of his folds containing about three hundred ewes, observed one of them lying on the hurdles, at the point of death. She was, in fact, in the last stage of variola ovina, and died shortly after. The carcase was put aside, and little was thought of the circumstance. In the course of a few days, other sheep of the same lot were attacked, and died in the same way; and Mr. Parry was soon made aware that his flock was becoming the prey of a new and fatal scourge. The two-year old ewes had up to that time been kept with their lambs; but, it being thought better to separate them, the lambs were removed and put with other lambs on the farm, the ewes being turned among the general breeding stock—making altogether a thousand ewes and seven hundred lambs. Unfortunately, both ewes and lambs carried the infection with them.

In about a fortnight—which, I may remark, is about the average period of incubation when the disease is taken in the natural way—the same symptoms began to show themselves in the flock generally. From this time the march of events was swift. By the end of July, more than four hundred sheep had been attacked, and two hundred or thereabouts had already perished. So rapidly and with such fatal effect did the leaven work.

Things were at this pass when, on the 1st of August, Professor Simonds, who had been summoned from London, arrived at Allington. "As the best means of saving the rest of the flock, and of putting a definite term to the outbreak, this gentleman resolved to inoculate the whole flock"—an operation that was performed without delay.

Before the epidemic ceased, it had spread to eight or nine other farms, and nearly 800 sheep had fallen a sacrifice to it. When I visited Wiltshire on the 13th September following, there were still, as I said before, some 700 sheep in various stages of the disease. Of these, some few had taken the disorder in the natural way, but by far the greater number by inoculation.

To the physician, not the least interesting thing was to see a measure, which once had so great a vogue as a means for disarming the malignity of human small-pox, employed with the same aims, and with precisely the same results, in the corresponding disease of the animal. In both, the common result was the evolution of a disease of incomparably milder type than when taken in the natural way. But the great importance of the phenomena presented by inoculation consists in the clear light they throw on the nature of the disorder. In the majority of the inoculated cases, the variola appeared in the mildest possible form. The eruption was limited to a single vesicle, and constitutional disturbance was slight or altogether absent. In some few, the course of events was otherwise; and the malady, although inoculated, took a malignant turn. One such case I saw. A sheep that had been inoculated some days before—in result, no doubt, of some individual predisposition—threw out a confluent eruption. The animal was at once sacrificed. Had the papulæ been allowed to develope into vesicles, there would have come from the minute atom of virus inserted by the lancet a few days before, a new crop sufficient to communicate the same disease to all the sheep in Wiltshire.†

Here, then, in results free from all ambiguity, and open to the eye, the great fact is revealed, that it is in the body of the sheep that this strange poison is fashioned and multiplied; and that the disease itself is the process by which it is bred.

In this one experiment almost everything is comprised.

We see, first, how minute a germ is sufficient to produce the disorder; we see, again, how, by reason of this very minuteness, signs of general disturbance are absent until growth has taken place; and, lastly, in the immeasurable multiplication which follows, we understand in what way provision is made for the extension of the disease, until, from a single first case, a whole epidemic is evolved.

The spectacle presented to us is, indeed, not new. To the physicians of the last century, as seen in the case of human small-pox, it was sufficiently familiar. But, for some reason or other, we have been singularly slow in applying the lesson it so plainly taught.

I may add, that one of the main points of interest in the fact here recorded is, that it repeats in one of the lower animals a series of relations that had already been observed of another and kindred disease in man.

† Professor Simonds has recorded several exactly similar instances in his work on *Variola Ovina*.

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We thus see, by the light of another pregnant and typical instance, exactly what a contagious fever is.

But what a form is this for disease to take! The phenomena, striking as they are when the result of inoculation, are still more so when they occur in the natural way. In the first instance, the mode of admission of the poison, at least, is known; in the second, it enters in through paths yet to be traced. Here, as in so many other cases, our perception of the marvellous nature of the facts is dimmed by our familiarity with them. In some sense, their succession is, no doubt, more or less clearly apprehended; but the language habitually used to express them seems to me to fall far short of an adequate statement of the mystery. What in the whole range of medicine is so striking as this invasion of the yet living and unbroken frame by a power which, like an evil spirit of the olden time—unseen, untraceable, and unbidden, enters in and takes possession, and holds riot and revel there, to issue forth again reinforced by a countless progeny? What so wonderful as this *imperium in imperio*, in which the majestic spirit that animates the human form is dethroned, and the noble form itself is often marred and laid in the dust, by a thing in comparison with which mildew and toadstool stand high in the scale of being?

To resume, then, we have it as the result of experiment, that the virus of variola ovina is bred in the body of the sheep. By the same means it has been ascertained that this virus is incapable of breeding in the body of any other animal, or, at least, of the great group of animals that are familiar to us, and that, like sheep, come into relation with us in our daily life. Pigs, horses, poultry of all kinds, dogs, cats, rabbits, monkeys, and even the goat, which in nature and organisation is, so to speak, but one remove from the sheep, have all been inoculated with it in vain.† The same fact holds good as to the ox tribe; and lastly, as to man himself. The experiments have been often repeated in various countries, and always, as far as I have been able to learn, with the same negative result.‡

† At one of the infected farms in Wilts, there was a goat which passed its whole time with the diseased sheep, and was inoculated more than once, but entirely without effect.

‡ See for details, Hurtrel d'Arboval's articles, "Clavelée", "Claveau", and "Clavelisation", in the *Dictionnaire de Médecine Vétérinaire*; and Professor Simonds' work on *Variola Ovina*.

As it was supposed that the virus might prove a substitute for vaccine, and might possibly give even a greater security against small-pox, the experiments on the human body have been more numerous than those on any other species. In spite of some few assertions to the contrary, nothing seems better ascertained than that man is entirely insusceptible of it.†

The experiments of the French and German schools fulfil every scientific requirement, and seem to be conclusive as to the point. The operation, performed, over and over again, on large numbers of unvaccinated children of different ages, always proved abortive. That the failure depended neither on constitutional peculiarity in the subjects, nor on defect in the ovine virus, was shown by a double test. The virus which had proved inert on the children promptly took effect on sheep, while on the other hand, the same children were afterwards vaccinated with success. These results have been verified in this country by experiments on a large scale by Mr. Marson, and by our honoured associate Mr. Ceely, whose name is the best guarantee for the accuracy of the facts. Conjointly, these gentlemen have performed no fewer than 250 vaccinations on the human subject, with the virus of sheep-pox.

"I ovinated twenty-five subjects," says Mr. Ceely, "whose ages ranged from three to fifteen years, some twice and thrice over; in none were there fewer than six punctures each time, making not less than 180 punctures: no specific disease resulted, but a prompt and devious papular or diffuse inflammation, or more rarely a common local pustular. In the majority of these twenty-five individuals the virus employed was liquid. When any recently charged points were used, subsequent re-inoculation with liquid virus took no other effect. Nearly all the above subjects were shortly afterwards vaccinated with current vaccine lymph, which in each case exhibited the normal effects. I may as well add, also, that the same kind of ovine virus which did not succeed on children, took promptly on sheep." (Simonds *On Variola Ovina*, page 154-5.)

Whether future researches may show these state-

† The chief, if not the only, witness on the other side is Sacco; but his evident desire to be looked upon as the author of important discoveries, and the fact that not one of his many alleged results have been verified by experiment in other countries, throw great discredit on his statements.

ments to be too absolute, I do not know;† but as they stand at present, they are in entire conformity with what common observation teaches.

In connection with this epidemic in Wilts, perhaps the most striking thing of all, was, that while the sheep were dying, by wholesale, of one of the most terrible of plagues, they were the only animals that suffered. So deadly was it to them, so entirely harmless to every other living thing. In more than one instance indeed, as we shall presently see, the infection passed from flock to flock, over a distance of nearly a mile in length.

But while even to be pastured in fields a mile away from an infected fold, was pestilence and death to sheep, the horses, dogs, oxen, swine, and other live-stock—even the starlings and flies which passed nearly their whole time on the sheeps' backs, with the organs thought to be most prone to receive infection, immersed in the variolous discharge, continued to enjoy the most perfect health.‡ Especially striking, considering the name the disorder bears, was the immunity of the *men* who had charge of the diseased flocks. Yeomen and shepherds fed largely on mutton, men whose bodies might not inaccurately be described as consisting in great part of mutton built up into man—might be seen there, handling the diseased animals in all manner of ways with the most perfect impunity. It is as if we were dealing with some chemical, of reaction so delicate that its presence can only be revealed by a single test; or rather (for this,

† I make this reservation, because it is easy to see, *à priori*, that experiments which issue in merely negative results require to be repeated a great number of times before absolute reliance can be placed upon them. Any one who will read the account of Mr. Ceely's admirable researches on the origin of vaccine, or who has undertaken experimental inquiries of this kind himself, will understand how necessary this condition is. But, after all, we scarcely need the evidence of experiment to show that this disease is peculiarly a disease of sheep.

‡ Professor Gamgee states, on the authority of Mr. John Percival, that a sheep dog belonging to Mr. Stephen Neate of Allcannings, whose flock suffered severely, took the disorder. In the many works I have consulted on the subject of clavelée, although the liability of animals, other than the sheep, is fully discussed, I have found no mention of a similar fact. It would have been well, under the circumstances, if Mr. Percival had tested the identity of the canine disorder by inoculating from the lymph it produced. It was at one time reported that Mr. Parry's dogs had clavelée; and, curiously enough, they were affected with a pustular eruption, but it bore no relation to the disease in the sheep.

no doubt, is the truer analogy) with some parasitic animal or plant, which finds in the organism of a single living species the only conditions of its life. I need not dwell on the extreme importance of this as a characteristic of a poison which is a standing source of wide-spread epidemics.

I may remark, however, that, in greater or less degree, it is a characteristic of the whole family of contagious poisons. Some few among them act in the same specific way on more than one kind, but the greater number seem to affect only a single species. In the most fatal epidemics of scarlet fever, yellow fever, measles, typhoid fever, and typhus, for instance; and it is most strange that so little stress should have been laid on a fact of such profound significance—the animals attendant upon man and in closest communication with him, never appear to suffer from the same plague. The value of the present instance consists in the fact, that it does not come to our knowledge by way of vague inference more or less open to doubt, but is established by the joint and irrefragable testimony of experiment and observation.

The same may be said of one more point on which I have to touch,—and nothing can show more decisively how entirely these contagious fevers are one family group than that you will all anticipate what I am about to say—the variola ovina, whether natural or inoculated, once occurring, exhausts the susceptibility to the same poison for the remainder of life. So that this poison not only breeds exclusively in the body of the sheep; but, as a rule, can breed even in the sheep's body but once in life.† So subtle, so incomparably specific are the conditions attaching to the reproduction of these contagious poisons.

But if the propagation of the disease, as studied by the light of inoculation, be thus instructive, its spread in what is called the natural way, as illustrated by the course of events in Wilts, was scarcely less so.

It will be remembered that the outbreak which began with a single case in Mr. Parry's flock, extended, before it died out, to eight other flocks. In nearly all

† I say as a rule, because exceptions to it happen under the same circumstances, and in about the same proportion as in human small-pox and in the other contagious fevers. Professor Gamgee has lately recorded an instance of such exceptions occurring on so large a scale as to imply either some peculiar liability in the particular flock, or something spurious in the antecedent attack.

those instances, not only had there been no direct communication, but, in more than one, the flock which became affected secondarily was separated from the flock which gave the infection, by a wide space. One of these flocks I visited. The field in which the sheep were then pastured was at least three-quarters of a mile, as the crow flies, from the sheep that had communicated the taint. The two flocks, the owner assured me, had never been in closer proximity than this. In the natural dread of so costly a scourge, he, as well as all the other sufferers, had guarded his sheep with the most jealous care; but the disease was, nevertheless, transmitted. The case of Mr. Harding's flock, of Etchilhampton, was still more remarkable. "The spot where the sheep were folded" (I quote from an account in the *Veterinarian*) "was about a mile and a half distant from Mr. Parry's farm, and in the intermediate space were other farms occupied by flocks belonging to different proprietors, and every care had been taken to prevent either direct or mediate communication with Mr. Parry's flock. As an additional precaution, the sheep had been driven to the part of Mr. Harding's farm most distant from Mr. Parry's."

Equally memorable was the infection of Mr. Church's flock, whose farm at Hillswood is some fifteen miles distant from the site of the Allington outbreak. This gentleman's sheep had been pastured in a field bounded by the high road, and over this road sheep from the infected district had passed to and fro. This was, as far as could be discovered, the only connecting link between the flock and the original focus of the poison.†

† On the 22nd of August, Mr. Neate of Allcannings, one of Mr. Parry's neighbours, sold two hundred lambs, at Marlborough fair, to Mr. Lousley. Two days afterwards, these lambs were sent back. When I wrote this address, I had been led to suppose that this particular lot of lambs had not, at that time, shewn any signs of infection. I have since been informed by Mr. Neate himself, that six of their number were in the first stage of variola when they passed back through Hillswood from Lambourn, on the 24th of August. On that day, Mr. Church's sheep were folded on a spot about a hundred and sixty yards from the road over which the infected lambs travelled. For several weeks they had never quitted the field in which they then lay. Mr Church, who has obligingly furnished me with these details, supposes that the taint was conveyed to his flock by his shepherd, who, *attended by his dog*, unwarily passed through the lot of infected lambs as they came along the road. There are, however, two great difficulties in the way of this supposition. In the first place, the six lambs affected with variola were in a stage of the disorder which is not generally believed capable of communicating infection. The very night before they had, in fact, been shut up in a yard with four hundred others;

The importance of these facts in relation to epidemics generally, will be readily seen. When events, at all parallel to these, occur in man, they are set down at once as altogether excluding the idea of propagation by communication of the morbific germ from the sick to the healthy.† And yet nothing can be more certain than that in the case before us the disease was propagated in this way. To argue the point at any length would be a waste of words.

The facts, first, that since sheep were first pastured on these uplands, this pest had never before appeared; and secondly, that the only sheep in all England that suffered were the neighbours of Mr. Parry's, and were affected long subsequently to his, are in themselves sufficient. These admitted, it becomes interesting to inquire in what probable ways the germ was transmitted from one flock to another. Several modes may be specified as having possibly intervened. The virus might have been conveyed—

1. By flies, or by starlings.
2. By men who had visited diseased flocks.
3. By sheep from the infected district.
4. By atmospheric dispersion, as it was cast off by the diseased animals.

Some have attempted to throw ridicule on the first of these supposed modes; but it was impossible to spend a day among the diseased flocks without seeing the great probability, to say the least, of its having had a share in the dissemination of the poison. From the disease being seated on the skin, the sheep were infested by flies and other insects to an extreme degree; all busy either in feeding on the variolous discharge, or in depositing eggs. The starlings, in their

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and, of these four hundred, not one took variola. In the next place, Mr. Church's first case occurred on the 27th of August, only three days after the passage of Mr. Neate's lambs, whereas eight days are the shortest known period of incubation. For these reasons, it seems more than doubtful whether Mr. Church's sheep received their infection at all from this lot.

† Human maladies are, it is true, not often transmitted through the air—on a large scale, at least—over such wide distances, for the simple reason, that sick men do not live "in the open air", like sheep, and are not massed together in the same way. But the difference is one of degree only. On the other hand, some of the most fatal and destructive of the epidemic diseases of men are propagated by discharges, which are often cast upon the open ground, and become the source of a widely diffused miasm. As these discharges are liquid, they are sometimes carried by gravitation to long distances, and the area of infection is thus greatly enlarged.

turn, came in quest of the larvæ of the flies. On approaching every fold of variolous sheep, a swarm of flies, and a great flight of starlings, rose into the air from their backs. As it is probable the attentions of neither were confined to the diseased flocks, it is easy to see how the virus might have been conveyed from one flock to another by their agency. That the disease may be carried from flock to flock by men has long been proved.

Professor Simonds related to me two decisive instances of the fact, which had fallen under his notice in former epidemics. Numerous others are recorded in works on "clavelée".

As Mr. Parry's flock was at first, naturally enough, an object of great curiosity to his neighbours and was visited by many of them, it is quite possible that the disease may have been in part transmitted in this manner.

For reasons on which I have not now time to enlarge, it was pretty certain, however, that the poison was chiefly diffused through the air. This is no doubt the way in which the virus of human small-pox is mainly distributed, and the diffusion of the two diseases appears to follow exactly the same laws. The well-known fact that both spread most rapidly and widely in hot weather, and especially in the absence of continued rain, is best explained by this view.†

The result may be brought about in two different ways: first, by atmospheric dispersion of the dried crusts resolved into impalpable dust; and, secondly, by the poison being wafted gently through the air in the form of "*nebulæ*"; to borrow Professor Simond's fine and suggestive expression—as it rises from the sheep's bodies.

Those who have had the good fortune to engage much in field-sports—a form of enjoyment equally invigorating to mind and body, and for men whose chief business in life is the observation and interpretation of nature, one of the best modes of training—will have no difficulty in conceiving this last mode of transmission. On a good scenting day, and with a favourable breeze, I have seen a pointer wind a covey which I had marked down a few minutes before,—and which

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† As regards human small-pox, this was first remarked by Sydenham, and has been verified by all experience since. Hurtrel d'Arboval states that variola ovina has been always observed to spread most in dry seasons. The absence of rain, I imagine, is the really important element.

had had no time to run,—very nearly the length of a long field. If the infinitesimally minute particles emanating at such a distance from some ten or twelve partridges, insensible as these particles are to us, can impinge on the olfactory nerve of the dog, with sufficient efficacy to enable him to recognise his game, and to excite his whole frame to spasmodic action, it is easy to conceive how, under favourable conditions of weather, the emanations from a large flock of sheep stricken with variola may be wafted by a gentle breeze through thrice that space, with full power to propagate the specific disorder.

Looking now, in a broad way, at the whole series of the events I have narrated, their interest is extreme, as showing, with singular precision and clearness, in what way and by what exact process of development, an exclusively contagious disease may, from a single first case, grow, in a short time, to an epidemic of large proportions.

As we have already seen, the disease eventually spread from the case of the ewe that lay dying by the hurdles, to eight other flocks, and many thousand sheep, occupying an area of several square miles, and extending into three counties. It is no objection to the facts that artificial propagation played a part in their production; for, had events been left entirely to their natural course, the spread of the infection would have been incomparably more rapid and wide.

Indeed, had not man intervened, had not the most stringent measures been taken to prevent the spread of the disorder, there can be no doubt that it would not have remained limited to the area to which it was restricted; but, as in all other countries in which the same precautions have not been adopted, would, like its congener, human small-pox, have overrun the kingdom, and become naturalised among us.

Now, what I wish you particularly to observe is this: that when events of this same kind occur in the case of man—when small-pox, typhus, typhoid, scarlet fever, or any other contagious fever, spreads thus widely and becomes epidemic—it is generally supposed that some new element has come into play, of an entirely different order from those which are in operation when the extension of the disease is confined to a single group. The case is not often, it is true, put in this distinct way. The phrases used are

more or less vague, like the ideas they represent. If nothing more were meant than that, when a contagious disease becomes epidemic there must be a concurrence of conditions favourable to its propagation by its known mode of multiplication, no exception could be taken to the view. But it is clear, from the terms in common use on this subject, that much more than this is implied. The two characteristics are put in direct opposition to one another, as things essentially different, if not antagonistic. Thus, small-pox, typhus, and the rest, are said, for instance, to be both contagious *and* epidemic. In the same way, variola ovina, the very disease of which we here treat, is said to be both contagious *and* epizootic. Even in their etymology, the two words express an antithesis.

Now, if this language mean anything, it means that when a contagious disorder becomes epidemic, the morbific agent has come into being in some condition, and by some mode of development, other than that which occurs when it is propagated by direct contagion from one individual to another.† That the contagious poison—to speak more plainly—*although known to breed in the living and infected body*, has, under some hypothetical influence of a general kind, been generated, in the epidemic season, by some totally different, and more pervading, source.

The events observed in Wiltshire are of incomparable value, as showing by data, which are scarcely inferior in severity and precision to those of the exact sciences, the entire fallacy of this view. For, be it observed, this epidemic in sheep was, in all essential things, the exact counterpart of the epidemics which infest mankind. There was the same evidence of growth from a small beginning until a large community was involved; the same commingling of cases in which the operation of contagion was evident, with others in which the connecting thread was lost in the mazes of a vague and manifold diffusion; and others still in which, from the nature of the events, under the common view of them, the very idea of contagion seemed to be altogether excluded.

Now, the strength of this case is, not merely that we see where and how the specific poison is actually

† This is shown still more strikingly by the language of not a few writers, who altogether invert the true relation, and while admitting certain disorders to be contagious, hold that they only become so when strongly epidemic.

bred—not merely that we have ascertained by experiment how marvellously exclusive are the conditions attaching to its growth—not even that in its immeasurable powers of growth we recognise an adequate source for all that follows; but that we exclude the intervention of every other source by the overwhelming evidence of a thousand years of antecedent immunity.

Every other element was here before, but clavelée never; the germ of the disease is introduced, and the result is what we witness. The history of human small-pox teaches, indeed, the same lesson; but in this outbreak of ovine variola we read it in characters still more plain.

To say that in the epidemics of contagious disorders other conditions may not intervene, in an important way, in the common result, would, of course, be absurd. But it is essential to all clear views of these high and complex questions, to see with the utmost clearness that these conditions are secondary only, and act solely in promoting the growth and dissemination of the one essential thing.

When locusts, from being more an object of interest to the naturalist than a serious cause of alarm to the grower of the mulberry and the vine, rise into swarms which darken the air, and sweeping beyond the bounds of the'r native habitat destroy the vegetation of half a continent, we all know that there must have been an unusual concurrence of conditions favourable to the multiplication of the insect. But we all know, with the same certainty, that it is the breeding power of the locust itself that has alone brought these countless hosts of winged enemies into the field. And so in disease. When small-pox, scarlet fever, or typhus, from being sporadic only, burst out into great epidemics, we all know that there must have been a concurrence of conditions favourable to the development and diffusion of the contagious poisons on which these diseases depend. But we all know with the same certainty, or rather, we all *ought* to know, that it is the reproductive power of these diseases themselves, which has alone brought into the world the new stock of the poisons from which they spring.

Three other topics remain on which a few words must be said before I conclude. What precise relation does variola ovina bear to human small-pox? How came it to spring up in Wilts? What were the

means by which, after it had risen to so great a head, it was finally extinguished?

The relation of the disease to human small-pox, interesting as it is, need not detain us long. In the introductory part of this address, we have seen how curiously close, as well as various, are the points of analogy between them. The name assigned, by common consent, to the ovine distemper shows better, perhaps, than anything else how striking they are. It is impossible, in fact, to see the malady—as you may yourselves, in part, judge from inspecting the accompanying drawings—without the idea of small-pox at once starting to the mind. But to presume upon actual identity in a case like this, on the ground of mere resemblance in outward characters—however accurate this resemblance may be—is to proceed on a false principle.

In the absence of other evidence, indeed, we must be content with such light as evidence of this order affords. But, in the present instance, there is another test that touches the root of the matter much more nearly.

These two diseases—the variola ovina and the human variola—are both things that breed. Each perpetuates its own species. If they be not two species, but one, it is clear, therefore, that in some way the one must have been derived from the other.

Now, tried by this test, the case seems to be decisive against the identity of these two maladies. We have already seen that man is proof against the ovine disease. He neither takes it in the natural way, nor can he be inoculated with it. The sheep is equally proof against human small-pox. Had human small-pox the power to generate this disease in the sheep in the natural way, British flocks would not have enjoyed so long an immunity from it. The inoculation of the sheep with small-pox virus is, on the other hand, always abortive; or, at least, produces nothing of the nature of clavelée. This, perhaps, would have sufficed of itself to decide the question. But there is another experiment, which, were it only for its subtle and delicate interest as a piece of scientific evidence, and for the train of associations it wakes up in the mind, I cannot withhold.

Vaccination, as we all know, offers a specific protection against human small-pox, which is all but complete; against ovine small-pox it offers no specific protection at all. It has been proved by experiments on an enormous scale, performed under every condition to insure accuracy, that vaccinated sheep, when afterwards exposed to the infection of *clavelée*, take the disease in large proportion in the natural way; and that, when inoculated with it, they not only incur the usual consequences, but suffer quite as severely as unvaccinated sheep.†

Until evidence to the contrary shall arise, the conclusion, then, seems to be inevitable, that variola ovina and human small-pox, closely as they resemble one another, are of distinct species. They are as two kinds of thistle—as one sort of mushroom to another sort—or as two species of algæ—like almost to identity in looks and outward guise, identical in all their laws of growth and being, but yet specifically different. This being so, the close resemblance between these two diseases becomes a matter for new interest. That, being so like that, to judge from first impressions, one would almost swear they were the same thing, each should have, against the other, such specific limitations of growth and power, is a fact of the deepest significance.

It is one more fact to show—if further proof were needed—what intensely specific things these contagious principles are; and, although we are in the habit of speaking of them as so many *poisons*, how different in essence they must be from our idea of poisons, when the word is used in its chemical sense. It only adds to the interest to know that the example here adduced is an example of a general fact.

I have endeavoured to illustrate the relation of human to ovine variola by a parallel drawn from organic nature. This parallel might be carried much beyond the present case, with strict adherence to

† There is, indeed, evidence to render it probable that for some weeks after vaccination sheep are somewhat less prone to take clavelée in the natural way; but there is clearly nothing specific in the protecting influence. Louis has remarked that typhoid fever hardly ever occurs in persons who may at the time be the subject of any other morbid disturbance. The two facts are, probably, of the same order. The failure of vaccination as a preventive of clavelée is the more important, because it produces in the sheep a disease which would appear to be the exact equivalent of vaccine. Hurtrel d'Arboval states that lymph taken from the resulting vesicle, and used for vaccination, produces the normal effects of that operation in man, and affords the same protection against small-pox.

nature and truth. For, if we extend our survey from the contagious diseases of man to those of the lower animals—not to speak of those of plants—we shall see that, as in the living flora there are tribes of thistles, of mushrooms, and of algæ, so among these morbific principles there are whole tribes also, bearing exactly similar and equally close resemblances one to the other, and yet specifically different.

In studying these things on an enlarged scale, we become, in fact, gradually aware that the singular agents which lead this parasitic existence, constitute a whole order to themselves: in their mode of growth and perpetuation, in their likenesses and differences, as, indeed, in many other things, the exact reflex of the organic types that people the world without, and on whose substance they prey. How have they all come into being? What, for instance—for the question will recur—is the relation between these two forms of variola, which in the drawings here look so wondrously alike? Although specifically different, may there not after all be some genetic connection between them? May not the one possibly be derived from the other by some such metamorphosis as that which naturalists begin to suspect is the key to that mysterious resemblance which runs through the organic types of the outer world? Or, rather—for this would probably be the truer way of putting the question—may they not be derived from some third, different from either, but the common progenitor of both?

These are problems of the future; problems of deep and various interest, but which must be postponed in the presence of the more pressing questions of the hour and day.

The origin of this remarkable outbreak in the Wiltshire flocks now comes to be considered. In regard to this point, I may as well state that the obscurity which hung over the first introduction of the pest is not yet wholly cleared away. At first the event seemed to be quite unaccountable. Mr. Parry had made no recent additions to his flock; and the seeming seclusion in which his sheep had for some time lain, appeared to shut out the idea of infection from any extrinsic source. These being the circumstances of the case, this outbreak was at once eagerly cited, by more than one writer of the dominant school in these matters, as a glaring instance of the spontaneous generation of a specific eruptive and contagious fever.†

This was the theory. The fact, divested of all theory, was simply that the specific germ, whatever its origin, which infected the first sheep, had not at that time been traced to its actual source. But, between inability to trace a minute and impalpable germ on the one hand, and proof of its spontaneous origin on the other, the distance is wide indeed. How wide, let mildew and mushroom, and all the countless kingdoms of organic types that breed by minute and impalpable germs, bear witness. If the evidence brought forward to show that this sheep-fever had sprung up spontaneously were of any worth, evidence of exactly the same order might be adduced to show that all these things spring up spontaneously too. Not only, however, has the spontaneous figment no real basis of its own, but the presumptive evidence against it, derived from the nature and history of the disease, is overwhelming. We know, in fact, how and where the poison of variola ovina is bred, and we have seen how incomparably specific and exclusive are the conditions attaching to its evolution.

Those who have weighed well what was said on this head will require, if I mistake not, something more than mere negative evidence to convince them that this is a poison which can be bred *de novo* out of the common conditions of sheep-life to be found in a Wiltshire farm. Against such a conclusion there is at once to be placed the decisive testimony of a thousand years of prior exemption. Since the Saxon first fed his flocks on those Wiltshire downs, this scourge had never once made its appearance there. Until nineteen years ago, the same might be said of England at large, under all the countless varieties of season, breeds, and sheep management, through these long, long centuries.

Enormous as is the weight of this fact as an argument against spontaneous origin, even when taken singly, its full force can only be appreciated when we contrast this immunity of ages with the frequent infraction of it during the short seventeen years which have succeeded to them. Of these two facts, each gives

† I speak here of medical writers, commonly so called. I must do the two eminent veterinarians who had charge of the diseased flocks the justice to say, that they neither of them, for a moment, gave any countenance to the popular cry in favour of spontaneous origin.

the interpretation of the other. Variola ovina was unknown among British flocks until seventeen years ago, because up to that time we virtually excluded the sheep of those countries in which the disease prevailed; it has broken out thrice since, because since that time we have admitted these sheep in enormous numbers and without restriction.

As regards the question of origin, the situation of this last outbreak was not without its significance. "Scotch farmers, we trust," says a Scotch writer, "may never see this disease: they are out of the way of the imported sheep." London is, in fact, the port through which they nearly all come in; and it will be observed that, of the three outbreaks of the pest which have already occurred in this country, not one has happened in Scotland or Ireland, or even in the north of England, but all in the south, and in those very districts which recruit their flocks most largely from the London market.

These considerations, which from the first were accessible to any one who would lay his mind open to them, might have prevented, one would have thought, that hasty resort, on the occurrence of the first difficulty, to a baseless and extravagant hypothesis, which it is so humiliating to think of, and which must look so strange in the eyes of men who cultivate the exact sciences. Since then a new fact has come to light, which shows how entirely premature such a proceeding was. About a fortnight or three weeks before this Wilts outbreak, a lot of foreign sheep infected with variola were sold at Smithfield to go into the west. This being so, two points in the topography of Mr. Parry's farm, brought into prominence by the local discussions on the origin of the outbreak, acquire special significance. On the first, Professor Gamgee lays great stress.

The farm, which, as we have seen, is situated at the foot of Beckingham Downs, was in part inclosed, in part open down. Now these downs are traversed in various directions by great sheep-tracks or driftways, which emerge, it is said, in the very heart of the open part of the farm. Through them sheep are driven in large numbers, partly for the sake of the wayside herbage, and partly for the evasion of tolls. Many instances have occurred, Professor Gamgee says, of the spread of contagious disorders, such as scab, the foot and mouth disease, rot, etc., from these infected flocks passing over the downs along the Wans Dyke—

the oldest of these tracks; and he suggests that it is more than probable that the sheep-pox was brought to Allington by the same secret and devious paths.†

The next point, which was, I believe, first brought to notice by Professor Simonds, is probably still more important. For some weeks before the beginning of the outbreak, Mr. Parry's sheep had been confined to

† I subjoin Professor Gamgee's masterly account of the topography of Allington.

"The farm of Allington, tenanted by Mr. Joseph Parry, stretches over St. Anne's Hill, or Tanhill, which is the centre of an extensive sheep district. It is also the locality in which there is an extensive sheep fair held annually on the 6th of August. Skirting this hill, and through the heart of the district about to be described, is the celebrated 'Wan's, or Devil's Dyke', one of the divisions of the old Saxon Heptarchy, and now levelled in some parts, but prominent at others. This Wan's Dyke takes a somewhat serpentine course from east to west. Standing on the Wan's Dyke at Tanhill, and circumscribing a circle with a radius of six miles, an area is embraced of about 70,000 acres of land resting on the chalk formation, with considerable tracts of the upper green sand, and the soils are proverbially healthy for sheep. Over this district there is in many parts one sheep to the acre, and the total amount of stock was computed in July to be about 50,000 sheep.

"The system of management consists in folding the sheep on fallow land or green crop, according to the season, extent, and quality of the down, to which the sheep are driven every morning from April to November. Each farm has, therefore, a certain amount of arable ground in the vale, and a strip of down on the hill. These strips of down are often connected with the arable land by a mere right-of-way or small strip of down, and the downs are limited for each farm by some faint undulation or mark, which we often fail to recognise, and which shepherd and farmer alone can define. Practically, the downs are quite unenclosed, though legally we understand that the land apportioned to each farmer is looked upon as fenced, so as to protect him from intrusion, and is considered enclosed ground. Our readers may imagine in what sense this may be accepted, when we tell them that we have ridden and driven for miles on the downs, straight through all the infected farms, without deviating right or left, and without passing ditch, hedge, stone wall, or gate.

"Standing on an elevated spot, the flocks are seen crammed in every part, moving side by side, one after the other, crossing each other's track, and affording ample opportunities for communion amongst the shepherds.

"The district is traversed in all directions by driftways, so that drovers can pasture their sheep on the downs for days, and go from Bristol to London with the payment of a single toll, or from Southampton to Ilsley, etc., in the same way. An extensive dealer has assured me that many hundred sheep driven for many days along the Wiltshire downs cost for travelling expenses 4s. a day. No money is needed for food, shelter, or tolls.

"There are some notorious dealers who have no farm or down on which to keep their flocks. They pick up odd animals at a low price, here and there, and drive over the downs, where they sleep, and move gently backwards and forwards on the pretext of travelling, but in reality getting food for their flocks. Many instances have occurred of the spread of contagious disorders, such as scab, the foot-and-mouth disease, foot-rot, etc., from these infected flocks passing over the downs along the Wan's Dyke."

two meadows in the lowland part of his farm.† At first sight, nothing could seem more complete than the insulation of these two fields. On looking a second time, an attentive observer would not fail to note that they were bounded through their whole length by the Kennett and Avon Canal. Along this great waterway trows are slowly dragged through all hours of day and night. In their multifarious cargoes, animal manure, and the raw materials from which animal manure is made, including skins, bones, and other offal, are said to figure largely. Now, if it be true, as reported, that a lot of the variolous sheep, just referred to as having been sold at Smithfield a few weeks before, died of clavelée on the banks of the Avon lower down, the appearance of this disease in a flock browsing on the bank of the Kennett and Avon Canal is no mystery. Under any view, it is extremely difficult to believe that the appearance of the foreign pest in these two particular fields had nothing to do with their proximity to a highway used for such traffic.

Here the case stands at present. Whether or not it will ever be more fully cleared up, I do not know. Probably not. In the present temper of the farmers of Wilts as to sheep's small-pox, the man who should be proved to have been even an unwitting instrument in conveying it to their flocks would not be likely to have a very pleasant life for some time to come. Under the circumstances, there is too much reason to suppose, therefore, that any information bearing on this point which might be forthcoming, would be suppressed by the only persons that have the power to give it. Meanwhile, we may rest assured that, if we have hitherto failed in tracking the infection home, the failure is not due to any real want of continuity in the thread, but simply to the inherent difficulty of following unbroken the course of

† In a paper by Mr. Gamgee, in the July number of the *Edinburgh Veterinary Review*, I find the following passage:—"The lowland portion of the Allington farm is skirted by the canal, and it is said that the sheep were near this canal when the disease broke out. I find, however, that the first case occurred amongst a portion of the flock that had been driven daily to the down for about a week. My authority is the shepherd who drove them."

When I was Mr. Parry's guest at Allington, the origin of the outbreak was the subject of much conversation; and at that time Mr. Parry's own impression certainly was, that for some weeks before the appearance of the disease, his flock had been confined to the two meadows in question.

such a gossamer. As for myself, I confess that I am quite indifferent whether the broken ends which we now hold be ever reunited, being of opinion that in the present state of science, when we see a case of variola ovina spring up, we are as much entitled to infer that the germ from which it came was derived from an antecedent case, as we are to draw the same inference in regard to human small-pox.

If, however, any should be disposed to cavil at the fact that the origin of clavelée in Wiltshire has not yet been made out in its every link, I would point to the two former appearances of the disease in England, in which even this last ground of objection is taken away. These first two outbreaks, indeed, as being much more wide-spread, and as offering a far greater number and variety of instances in which the communication from flock to flock could not be traced, were, if possible, even better illustrations of epidemics generally than that we have been endeavouring to follow. In both, as I have said before, the exact trail of the infection was tracked from the foreign seaport to the two farms in Berks and Norfolk, from which it afterwards spread so widely.

The measures by which, after it had risen to so great a height, this pest was finally suppressed, were simple enough. They were founded, in fact, on the single principle that variola ovina is an exclusively contagious disorder, to be extinguished only by preventing the spread of contagion in all possible ways. Perfect insulation of the diseased flocks for several months, as enforced by Order in Council; instant separation of the sick from the healthy in the infected flocks themselves; the immediate slaughter and burial of badly diseased animals; the disinfection of tainted homesteads, and of the tainted fleeces of the sheep—this was the code of measures brought into action against this new enemy. Carried out with the vigilance and untiring energy which are often so sadly wanting when the interests of health only are concerned, but which never fail when the interests of the pocket are largely at stake, they perfectly succeeded. Before the beginning of November, this scourge, which from the ewe that lay dying by the hurdles had extended to some eight or ten thousand sheep, had come to an end; and, by measures directed solely against contagion, British flocks were once more delivered from a great peril, and the nation

from incalculable loss. That the result should thus answer to the theory was the only thing needed to put the seal to the history, and to make the whole case logically complete.

Thus have we seen a great epidemic unfold itself, from its first small beginnings to its final extinction, in which the *rationale* of the whole series of events is made as clear as day. In these events, a specific germ, endowed with the faculty of immeasurable multiplication, open to various modes of untraceable dissemination, and having power over a single living species, is the only new element. In the incalculable minuteness of this germ, and in its equally incalculable faculty of growth, we find a key to all the phenomena. Manifold, complex, subtle, and intricate as the results are—in all these things so characteristic of epidemics generally—it comes before us with all the force of absolute demonstration, that they all fall under the single great law of the evolution of a specific type by continuous succession. What, above all, in this spectacle, is most to be prized, is the admirable clearness with which this great truth comes out. As we see with what precision, one by one, all the essential data bearing on our problem are elicited by experiment or made plain to observation; as we observe how the few remaining ambiguities which experiment and observation leave untouched are at once swept away by the great fact that the disease before us, although prevalent from all time in other countries, is new to our own—we seem to have left the vague realms of physic, where a balance of conflicting probabilities constitutes for the most part our nearest approach to truth, for the precise and rigorous demonstrations of the physical sciences.

Not less valuable is the whole history of this disease, for the signal record it bears against the doctrine of spontaneous origin as applied to contagious disorders. Resting on purely negative data, this doctrine is a mere figment of the mind.

The offspring of a crude and early stage of scientific culture, it has come down to us as a tradition of that phase so familiar to the student of the history of science, in which things are thought to be what they first seem, and the outward semblance is taken to be the real relation. In the nineteenth century, it is an anachronism. Among the contemporaries of Eschricht, Owen, Milne Edwards, Pasteur, and Carpenter, it should have no place.

It is to the last degree significant that wherever, in its application to this group of diseases, the question can be tried by experiment, or by the light of geographical distribution, or of data equally binding, it receives a decisive negative. Only in connection with the types that cannot be so dealt with does it still linger. Discountenanced by the whole analogy of nature, shown to be untenable in every case in which definite evidence can be brought to bear, this belief in the spontaneous origin of specific contagious diseases has already received its death-blow, and, like the strictly correlative belief in the spontaneous generation of plants and animals, is doomed soon to take its place among the things of the past.

This address, already too long, would, nevertheless, fail of all its purpose, if I brought it to a close without applying the truths it was intended to illustrate to the contagious fevers of our own race. For the present, I will content myself with a single example.

The fever I shall take is one with which you are all familiar; the typhoid fever of man. Like variola ovina, this, too, is a contagious fever, having a period of incubation, and occurring but once in life; a fever which multiplies as it goes, and is marked by a specific eruption. For, although the character of which I speak, in the last instance, is seated on the intestine and not on the skin, you cannot doubt, if you will look at the drawings and photographs here exhibited, that such is its true definition.

Compare these drawings for a moment, with unprejudiced eye, with the drawings by their side, representing the eruptions of human and of ovine variola; remembering the while, that in each case you have before you the one and only specific mark of a contagious fever, and you will not, I think, fail to see that, in all, you are looking on phenomena of the same order.

But the several characteristics just enumerated are the highest conceivable by which two diseases can be related. Nothing can show more forcibly how entirely they touch and spring out of the essence of the morbific agent in each case, than the fact that they are found alike in the animal and in man. These two things, the ovine and the human fever, are, clearly, in the highest and most intimate sense of the words, things of the same sort. In all their modes of being they follow the same law. They are members of one

family, in fact, as much as two kinds of mushrooms are; and, I may add, in the same sense.

Knowing the law of propagation of the one, we may apply it to that of the other, with the same certainty as we apply the law of propagation of one kind of mushroom to that of another.

If typhoid fever, like variola ovina, has a period of incubation—an interval, that is to say, in which, after the reception of the germ, no appreciable morbid phenomena occur—we have learnt by experiment what this implies.

We know that in the contagious fevers this most significant of characteristics depends on the fact which, in one of these two cases, is *patent to the eye*, that these diseases are caused by poisons which only develope their effects by growth within the living body, from a germ which, in the first instance, is too minute to exert any sensible action upon it. By the surest of inductions, therefore, we become possessed of the great cardinal truth, which I have already enunciated elsewhere, that the human body is the soil in which the typhoid poison breeds and multiplies, and that the fever itself is the process by which it is evolved.

Once more, if typhoid fever, like variola ovina, occur, as a rule, but once in life, we know—for in one of the two we have ascertained the fact by experiment—that this is because, even in the living body, this poison cannot breed a second time. By the help of the same analogy, we may be equally sure that it never springs up spontaneously, but is perpetuated solely by the simple law of continuous succession.

Lastly, we may assume with the same certainty that the intestinal eruption represents the chief, if not the only out-come of the specific poison, since it is from the *variolous* eruption, the exact counterpart of this, that we charge our lancet when we proceed to the inoculation of the ovine disorder. But if so, what an opportunity is here! This typhoid poison, thus cast forth in a liquid form to infect the ground and the sewer, slays every year, in England alone, its eighteen or twenty thousand men. As it issues from the body, it is entirely within our power. By destroying it we may bar the succession, and throw the impenetrable shield of science between the poisoned shafts and the next group of victims.

It is easy to see how many difficulties may stand in the way of the universal and perfect accomplishment even of this simple act. The extent to which it may be enforced depends much on ourselves. If we put only half the energy into the work which the Wiltshire farmers displayed in preventing the spread of the clavelée among their flocks, we shall soon reduce the twenty thousand who perish annually from typhoid fever in England to a low figure, and pave the way to the speedy and entire extinction of the pest. For myself, I never see the exuviæ which contain its deadly seeds cast carelessly upon the world, without thinking how many homes may possibly be made desolate by that single act, and how great is the inconsistency which passes Acts of parliament, and imposes heavy penalties to prevent the destruction of some five or six hundred lives by arsenic and other poisons, and yet allows a poison which destroys its twenty thousand every year, to work its will upon the people.

One word more, and I have done. I said, that in applying the case of clavelée to the illustration of our own diseases, I would confine myself to a single example. But it is obvious, that the principles which that disease brings so clearly into view, apply with the same strictness to the propagation of the whole group of contagious fevers, and with greater or less promise of success to their prevention also.

If, instead of allowing our minds to be diverted by the baseless and obsolete notion that these fevers may spring up spontaneously, or by the unscientific idea that they may be generated by filth or other external conditions, we concentrate our attention on the great truth that it is in the living body only, that the specific poisons on which they depend are bred and perpetuated, we shall soon learn ways greatly to abate their ravages.

If I might be allowed to express the one sentiment that fills my own mind in relation to this subject, it would be this:—that it is high time we should join, with concerted aim and more earnest purpose, in efforts founded on this principle to deliver our fellow-men from these great scourges. To this course we are, in fact, moved by every high consideration that can impel men to action.

These fell disorders are always crossing our path. They defy our art, and seem to mock our power. Their presence is a standing humiliation to us. They cause the greatest and the bitterest tragedies we are called upon to witness. They leave desolation and

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mourning and widows and orphans in their track. Take the single case of scarlet fever, and what heart-rending scenes does not its very name evoke. Let this terrible fever sweep through a community and one seems to have for months ringing in one's ears "the voice of Rachel weeping for her children, and will not be comforted, for they are not."

Unhappily, this great Hydra of contagious diseases is not a thing that can be slain, like the Hydra of old, in single combat. Thanks, however, to the power of human genius we have already discovered that of its myriad heads, some at least are mortal. And, although to no one of us will ever be given the strength to repeat the exploit of Hercules, we may hope that, when science has forged the fitting weapons, by banding together as one man we may yet rid the earth of the monster.

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Dr Parkes
with the kindest remembrances of J.W.B.

VASCULAR BRONCHOCELE

AND

EXOPHTHALMOS.

BY

J. WARBURTON BEGBIE, M.D.,
PHYSICIAN TO THE ROYAL INFIRMARY.

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VASCULAR BRONCHOCELE AND EXOPHTHALMOS.

THAT an affection characterized by so remarkable a tetrad of symptoms as palpitation of the heart (often violent in degree), notably increased pulsation of arteries, prominence of the eyes with peculiar startled expression, and enlargement of the thyroid gland, should, when once accurately observed and definitely described, have attracted a large share of professional attention, is by no means surprising. This odd form of disease,[1] as a recent distinguished writer has called it, is certainly not new,—it has only remained for a lengthened period unobserved or unappreciated; its history in this respect not differing from that of several other ailments which recent research has alone brought to light; as, for example, Bright's disease of the kidneys, leukæmia, and the rheumatic inflammation of the cardiac structures. That the association of two, and even of all the symptoms referred to, had, moreover, been occasionally noticed, long before any proper conception of their importance had been formed, is abundantly clear from the cases recorded by Flajani,[2] by Dr Caleb Parry,[3] and certain anonymous writers, particularly in the Medico-Chirurgical Journal and Review.[4] By Dr Graves, the cardiac affection and enlargement of the thyroid gland were accurately noted and described in 1835; and, subsequently, Dr Stokes particularly alluded to the enlargement of the eyes in relation to the other features. In 1839 the disease was carefully observed by Dr Begbie; and, in the course of the succeeding ten years, again and again recognised,—till, in the form of a memoir, his observations, comprehending a theory as to its origin, the proof of its amenability to treatment, and important suggestions as to the means to

[1] "Cette maladie si *bizarre*, pardonnez-moi cette expression," etc. Trousseau, in the report to the French Academy.—Bulletin de l'Académie Impériale de Médecine, tome xxvii. p. 996.
[2] Collezione d'Osservazioni e Riflessioni di Chirurgia, tome iii.
[3] Unpublished writings of the late Dr Caleb H. Parry, vol. ii.
[4] For February 1816.

be employed, were brought before this Society in 1849.[1] Meantime, both in this country and on the Continent, the disease had attracted the attention of physicians,—earliest in Germany, that of Basedow, who, under the appellation of "cachexia exophthalmica," described it.[2] It is for Basedow that Hirsch and others have claimed a priority of observation, and, conformably to a practice which finds favour with many, have sought to identify his name with the disease; Basedow's disease (Maladie de Basedow) is the title under which these writers have presented their observations and recorded instances of the malady in question. Trousseau, on the other hand, whose high admiration for the character and writings of the distinguished and lamented physician of Dublin, Dr Graves, is well known, and can only be most agreeable to us, has determined that the disease shall be recognised as Graves's disease (Maladie de Graves); and thus he has styled it in the recently published volume of the Clinique Médicale de l'Hôtel Dieu de Paris. It is, however, only fair to Dr Stokes to observe again, that the first distinct reference by the Dublin physicians to the enlargement of the eyeballs, in connexion with palpitation of the heart and enlargement of the thyroid gland, was made by him when communicating the particulars of a case to Dr Graves.

Of the actual existence of such a disease as that described by Graves, Stokes, Basedow, Begbie, Trousseau, there can be no question; whoever has had the opportunity of seeing and carefully studying a single well-marked instance of the phenomena referred to, must admit the entity of the disorder whose characteristic features they are. The case brought before the Imperial Academy of Medicine at Paris in April 1860, by M. Hiffelsheim, and that produced by the late M. Aran, when engaging the attention of the Academy with the same subject in the December following, are admirable illustrations of the disease, and wholly satisfactory as proofs of its separate and distinct nature. In the very important discussion in the Imperial Academy which succeeded the reading of these cases by MM. Hiffelsheim and Aran, only one speaker attempted to throw discredit on the observations,—to challenge the correctness of the view which assigned to the assemblage of symptoms under discussion the dignity of a specific morbid state or disease. "There does not exist," concluded M. Piorry, on 22d July 1862, "a morbid unity called diathesis, cachexia, or neurosis, constituted by a triad, or a tetrad, or a pentad, or a polyad of symptoms, and which merits the name of exophthalmic goitre." I am not aware of any other expressed opinion in accordance with that of M. Piorry, while a subsequent speaker in the same discussion, M. Bouillaud—not less than M. Piorry himself—has thrown some fresh light on the real occasion of the extraordinary statement

[1] Monthly Journal of Medical Science, 1849.
[2] Casper's Wochenschrift, 1840.

just quoted. M. Bouillaud's parole, on the 5th of August, commences as follows:—"Gentlemen, before proceeding to the subject of discussion, I desire to pay a just tribute of praise to the two eminent colleagues (MM. Trousseau and Piorry) who, during the two former sittings of the Academy, have occupied the tribune. Happy the Academy, if, renouncing certain notorious antecedents, these two orators had in some sort extended the fraternal hand, and had afforded us the edifying and agreeable spectacle of a reconciliation which science would not have failed to applaud. The hour for the consummation of so desirable an event is not yet arrived." But, not only is there a disease mainly characterized by the features adverted to, the malady in question is very far from being uncommon in its occurrence. From the period when Dr Graves wrote, there is scarcely a country in Europe in which the disease has not been met with and described; while, in our own country, in France, Germany, and other parts of the Continent, it has formed the subject of many interesting, and some extended, observations. In America, likewise, it has not been overlooked. I am satisfied that in this city the disease is of frequent occurrence, and, in hospital practice, have often encountered it. No session has passed since my appointment as physician to the Infirmary during which the opportunity has not been afforded me of directing the attention of a clinical class to the remarkable phenomena the disease presents; while, as a general rule, my experience has been that of the last session, several cases having come under our notice. Up to the time when Dr Begbie wrote, the instances of this disorder which had been recorded were merely isolated examples,—or were, at all events, related as illustrations of what was properly regarded as a remarkable combination of symptoms, without any attempt being made to explain their occurrence or production. Thus, Parry, to whom undoubtedly credit belongs for having early and independently noticed the association of two of the symptoms, observes:—"There is one malady which I have, in five cases, seen coincident with what appeared to be enlargement of the heart, and which, so far as I know, has not been noticed in that connexion by medical writers. The malady to which I allude is enlargement of the thyroid gland." It is perhaps scarcely correct to affirm that Dr Parry attempted no explanation of the coincidence he had been shrewd enough to observe; but, as regards the causation of the enlarged thyroid, all he remarked was as follows:—"One can scarcely avoid suspecting that the thyroid gland, of which no use whatever has hitherto been hinted at by physiologists, is intended, in part, to serve as a diverticulum in order to avert from the brain a part of the blood, which, urged with too great force by various causes, might disorder or destroy the functions of that important organ." And so also, in a way equally accidental, Dr Graves wrote,—"I have lately seen three cases of violent and long-continued palpitation in females, in each of which the same peculiarity presented itself,—namely, enlargement of the thyroid gland; the size of the gland, at all times considerably greater than natural, was subject to remarkable variations in every one of these patients."[1] Equally true is it that no explanation of the phenomena was, in the first instance, offered by Pauli or Basedow in Germany, or by Dr Macdonell or Sir Henry Marsh in Ireland, by whom, meantime, interesting cases had been observed, and, in considerable detail, recorded.

When Dr Begbie, in 1849, brought his observations on enlargement of the thyroid gland and eyeballs before this Society, he regarded these appearances as the consequences of anæmia, and this substantially is the view he still entertains.[2] A similar opinion has since that time been expressed, specially respecting one of these symptoms,—namely, the prominence of the eyes,—by several distinguished oculists. Dr Mackenzie of Glasgow, for example, styles this condition "anæmic exophthalmia." Mr White Cooper and Dr Robert Taylor have respectively described it as "protrusion of the eyes in connexion with anæmia, palpitation, and goitre," and "anæmic protrusion of the eyeballs." The anæmic theory as to the origin of the malady has, therefore, found much favour with ophthalmogists; it has likewise been adopted by physicians who have had the opportunity of devoting attention to the consideration of the whole phenomena. Among such may be mentioned the late Dr Bellingham of Dublin and Dr Isaac E. Taylor of New York. The former able writer thus expressed himself:—"The affection may be regarded as one of the rarer results of anæmia, as first pointed out by Dr Begbie; indeed, the subjects of it present the ordinary characters of anæmia; they are generally pale and chlorotic looking, and often labour under amenorrhœa, leucorrhœa, and menorrhagia; they suffer from indigestion, impaired appetite, disturbed sleep, short cough, coldness of the extremities, headache, ringing in the ears, and palpitation; while various nervous or hysterical symptoms, as intercostal neuralgia, or spinal irritation, are occasionally present."[3] But, while all observers of this disease have recognised its connexion with anæmia, there are several—and among these some of the best of recent writers—who have hesitated to assign to a simple blood impoverishment the important rôle which, in the view of the other writers named, it is considered to play. Anæmia is confessedly present in a large proportion of cases; but, inasmuch as that condition did not precede the development of the characteristic features in some instances, while in others it only became manifest after these had been in existence for a considerable period, it cannot, they argue, be regarded as an adequate explanation of their production. Unable to recognise the existence of anæmia in connexion with the palpi-

[1] Clinical Lectures on the Practice of Medicine, vol. i. page 193.
[2] Contributions to Practical Medicine, page 176.
[3] A Treatise on Diseases of the Heart, page 532.

tation, the enlargement of the thyroid gland, and remarkable appearance of the eyes, some observers, more particularly on the Continent, having noticed the association of these symptoms with a condition of the general system more or less depraved, have described the disease under the by no means definite or distinctive appellation of a cachexia. Thus, Basedow in Germany, to whom reference has already been made, uses the expression Cachexia exophthalmica (Glotzaugencachexia, literally, large staring eye, or goggle-eyed cachexia); Withusen, that of Cachexia exophthalmica; and Hervieux, with Fischer and other French writers, terms precisely similar,—as, Cachexie exophthalmique, L'exophthalmos cachectique. In the former of the two valuable papers on the subject recently read by Dr Laycock to this Society, it is implied that certain German writers have identified the so-called exophthalmic with the strumous cachexia.[1] In the descriptions of Romberg and Henoch, whose contribution bears the title, "Herzkrankheit Struma und Exophthalmos,"[2] and in the observations of Schoch, entitled, "De Exophthalmo ac Struma cum Cordis Affectione,"[3] I have, however, been unable to find any warrant for this assumption; they have merely employed the word "struma," as it is often used by German writers, in a sense synonymous with bronchocele, and having no reference to that bad habit of body which English and other writers designate as the strumous. I have said that the term cachexia is by no means a definite one; the meaning attached to it by different writers varies considerably; as we meet with it in medical literature, it is not in all circumstances possible to ascribe a uniform, exact, or clear signification to it. While, by certain physicians, the word cachexia, and, perhaps still more, cachectic, is used to denote the existence of some profound, indeterminate, and irremediable vice of the organism, by others the term is not understood in so formidable a light. Trousseau, who has evidently the most serious view of a cachexia, sees none in the "maladie de Graves;" and, again, by Basedow and others, who have employed this word in their descriptions of the disease under consideration, it has very evidently been used as precisely synonymous with chlorosis, anæmia, or hydræmia. This is very clearly shown in the able observations of M. Beau during the discussion in the French Imperial Academy of Medicine.[4] Lieutaud, he reminds the Academy, was the first to employ the term anæmia, though long antecedent to his time the characteristic features of anæmia had been with accuracy observed,—to wit, pallor, swelling, feebleness, and flaccidity, which most readily arrest attention,—and to the same assemblage of symptoms the word cachexia has also been applied. M. Beau further quotes from Felix Plater a passage, in which, under the name of cachexia,

[1] Edinburgh Medical Journal, February 1863.
[2] Klinische Wahrnehmungen und Beobachtungen, 1853.
[3] Dissertatio Inauguralis. Berlin, 1854.
[4] Bulletin de l'Académie Impériale de Médecine, tome xxvii. page 1101.

precisely the symptoms of anæmia, as now generally understood are included,—to use M. Beau's own language, "the ordinary symptoms of our modern anæmia." Every feature of anæmia is indeed noticed in this description of cachexia by Plater, if we except the important auscultatory phenomena, the discovery of which was reserved for Laënnec and his successors. "Cachexia," he says, "is a disease accompanied by discoloration of the skin, in which the florid hue is lost, and, for the most part, the proper appearance of the body is changed; hence the term cachexia. In this disease the skin becomes white, or grows pale, or acquires a livid hue, or turns to a leaden aspect, while the surface of the body acquires a swollen appearance. The affection is generally accompanied by dyspnœa, which chiefly attacks the sufferers in walking, or ascending heights, with palpitations of the arteries in the neck, and of the heart, and with weakness of the limbs. While (Plater concludes) all may suffer from this disease, it is peculiarly apt to affect young women." The cachexia, then, which is thus defined, or a condition nearly identical with it, is evidently the state or appearance of body with which the more remarkable features of the disease under consideration are held by some writers to be associated. And this cachexia is surely nothing more or less than an anæmia. In such a depraved condition of body as either of these terms may be held to express there is noticeable—pallor of the tissues, muscular feebleness, softness or flaccidity of flesh, and not unfrequently œdema. Associated with these well-marked features there exist, usually in a distinct form, the peculiar auscultatory phenomena connected with the heart and arteries, and with the veins, chiefly those in the neck, which have been generally supposed to result from an impoverished condition of the blood, as well as palpitation of the heart and pulsation of the arteries, and many other less important, because not constant, symptoms. Dr Laycock has objected to the value usually attached to the hæmic murmurs as evidences of anæmia; nevertheless, I am thoroughly persuaded of their importance. In instances of marked anæmia, I have never failed to detect the systolic soft blowing murmur at the base of the heart, the arterial souffle in the arteries of the neck, and the humming-top sound—bruit de diable—in the jugular veins particularly, but not unfrequently in the femoral and brachial. For their production, in anything like perfection, I believe two circumstances to be requisite; firstly, a marked excess of water over the corpuscular elements of the blood, and, secondly, a considerably exalted action of the heart. When these conditions have co-existed, I have never failed to identify the cardiac and vascular hæmic murmurs. I have found all of these, though never well marked, in cases which presented little if any of the general features of the anæmia or cachexia already adverted to; and I have failed to distinguish them in some instances of sufficiently anæmic or cachectic individuals. In the former case there has probably been that excess of water over blood-corpuscles which

is, I believe, required for their production, though the external characters of anæmia were not pronounced, and the absence of the sounds in the latter case was probably due to the feeble action of the heart. In ordinary examples of splenic leukæmia, I should not expect, and have not found, hæmic murmurs, for the corpusclar element of the blood in them is far from being deficient, and I cannot agree with Dr Laycock in regarding their usual absence in such cases as militating against the valuable information their presence in other circumstances affords. In chronic Bright's disease, if hydræmia has at the same time existed, and the heart's action been moderately strong, I have never failed to detect them. In the disease under consideration, I have always found these murmurs. The loudest hæmic murmur at the base of the heart, as well as the most distinct venous bruit in the neck I ever heard, were in a well-marked example of associated exophthalmos and bronchocele.[1] It must here be observed, that, by those physicians who have in the strongest manner upheld the blood origin of the cardiac palpitation, and arterial pulsations, the enlargement of the thyroid gland, and prominence of the eyes, the coincidence of remarkable nervous symptoms with these phenomena has not been overlooked. But while evidently impressed with a sense of their importance, their nature and even their occurrence being far from uniform, they have been viewed by such either as accidental or, as at most, accessory symptoms; and, even by those who have specially noticed them, have been ascribed, like the other phenomena of the disease, to the impoverished condition of the blood. More recently, several experienced writers and observers, in explaining the causation of the various symptoms, have attributed these to an affection of the nervous system, and have regarded the anæmic or cachectic appearance presented by the sufferers, as resulting from the long-continued nervous disorder. Dr Stokes, in his work on Diseases of the Heart and Aorta, has styled the disease a special form of cardiac neurosis. "There are," he says, "strong reasons for holding that the disease is originally a neurosis of the heart, and, perhaps, also of the cervical vessels themselves;"[2] and Withusen, the able Danish writer already referred to, has remarked, "We must, therefore, adhere to

[1] The microscope affords important information in anæmia. I am satisfied that there may be the pallid appearance of countenance, and the other general symptoms of this condition, in cases in which the auscultatory phenomena adverted to have little or no existence. In such cases the microscope detects no deficiency of the red corpuscles; but they have an altered appearance, are much less coloured, are serrated in their borders, and rarely form rouleaux. This condition, as well as that of a true hydræmia, may exist in the advanced stages of renal disease. I have now under my care in the Infirmary, a sufferer from chronic Bright's disease, whose look is so sufficiently cachectic or anæmic as in connexion with infra-orbital œdema, to suggest at first sight the malady under which he labours. Auscultatory phenomena exist, but in feeble measure. His blood is not watery, yet it is certainly impoverished; it is deficient in colouring matter, and the corpuscles are unlike those of health.

[2] Page 293.

the opinion that we have, in such cases, to deal with a nervous affection of the heart, which may indeed give rise to organic cardiac disease, but does not necessarily do so; to attempt to demonstrate the source of the affection would, as we cannot find it in anæmia, with our present materials, be a fruitless labour, and would lead us far into the region of hypothesis."[1] It is now four years since Koeben expressed the opinion that a lesion of the sympathetic best explained the entire phenomena; and in 1860, the late M. Aran, having diligently studied the disease, and having brought the subject under the attention of the Imperial Academy of Medicine, concluded that, in all probability, the primary seat of the disease was in a lesion of the grand sympathetic. M. Trousseau, who has of late had considerable clinical experience of exophthalmic bronchocele, and whose views on the subject may be found at length in the discussion before the Imperial Academy, in which, as "rapporteur," he took a very prominent part, as well as in the second volume of the Clinique Médicale de l'Hôtel-Dieu de Paris, rejects the anæmic theory as to its causation, and regards the anæmia as secondary to the cardiac palpitation, the arterial pulsations, and the phenomena connected both with the eye and thyroid gland. "Anæmia," he says, "is an epiphenomenon; it is secondary, sometimes tardy in its development. The morbid cause acts primarily on the heart, and it is not till the lapse of a certain time, more or less considerable, that the blood is modified in the constitution of its elements. The woman in bed 34 of the ward St Bernard, presents at this time the features of anæmia; these features were not, however, in existence when she came under our care, although the disease had then continued for nine months. A neurosis of the grand sympathetic had preceded the anæmia." Again, the same distinguished physician observes, "The disease is, in my opinion, a neurosis with local congestions, having its proximate cause in a modification of the vaso-motor apparatus."[2]

There may then be said to exist, at the present time, two theories respecting the origin of the singular and interesting ailment we are considering. The one, that it depends upon anæmia, a blood impoverishment; the other, that it results directly from a disorder of the nervous system, is a neurosis depending on lesion of the vaso-motor apparatus. I am strongly inclined to think that the true explanation of the pathology of the disease rests somewhere between these two propositions. Neither the state of the blood, nor the condition of the nervous system, as the point of departure, "the primum mobile," is to be overlooked. It may be conceded that all the symptoms which go to constitute anæmia may result from disorder of the nervous system, and by such disorder will assuredly be aggravated; still, if it can be found that the features of

[1] On the Cachexia Exophthalmica of Authors. Translated by Dr W. D. Moore, Dublin Hospital Gazette, July 13, 1859.

[2] Clinique Médicale de l'Hôtel-Dieu de Paris, tome ii. page 645.

the former malady were in existence before there was any evidence whatever of nervous disturbance, we shall feel entitled to consider that the blood alteration was first in the order of events. That in most, if not in all, of the cases of associated exophthalmos and bronchocele this holds true, is, I think, probable. No doubt, this opinion will be controverted by some physicians, whose statements are entitled to respectful consideration, but having already pointed out that the anæmia of the writers who adopt the humoral pathology of the disease is in all probability identical with the cachexia of those who have rejected it, I feel there is some ground, even in their own statements, for the opinion just expressed. When, in addition, a careful study and analysis of the numerous cases recorded by different writers is made, there are undoubtedly afforded very strong reasons in favour of anæmia operating as their cause. The following particulars under this view of the subject must not be lost sight of. *First*, That the sufferers from the disease have, in a large proportion of cases, presented adequate causes for blood impoverishment. These causes have varied in different cases—the more frequent in their occurrence have been uterine hæmorrhage, hæmorrhoidal flux, long-continued leucorrhœa, amenorrhœa, prolonged lactation, lientery, and diarrhœa. While so suffering, the occurrence of the enlargement of the thyroid gland, or the prominence of the eyes, or both, have not unfrequently been preceded by some cause acting injuriously on the nervous system, particularly such as excited the emotions or passions,—grief, fear, fright. *Second*, That the sufferers have themselves, in numerous instances, presented the characteristic features of anæmia, pallor of countenance, feebleness of limbs, and flaccidity of tissues, tendency to œdema, palpitation of the heart, and the peculiar auscultatory phenomena connected with the heart and bloodvessels, to which reference has already been made. And it is while these symptoms in succession to some adequate cause of blood impoverishment have been in existence that, either spontaneously, or apparently resulting from some injurious operation on the nervous system, the bronchocele and proptosis have appeared. *Third*, That the remedial means which have hitherto been directed to the relief of these symptoms, with most decided effect, are just those which, in the treatment of anæmia, are confessedly of the greatest service; and *Fourth*, That the structural changes to which the central organ of the circulation is subject are of the like kind with those which result from its long-continued functional derangement in connexion with anæmia when assuming its more ordinary characters. There are then, I repeat, very cogent reasons afforded by clinical observation for associating blood impoverishment with exophthalmos and vascular bronchocele, and for assuming that they stand to each other in the relation of cause and effect. A diligent study of the phenomena of the disease must, however, satisfy all, that the anæmic theory, as thus expounded, stops short of explaining all the peculiar features of such cases, even when the anæmia is best marked, and, still more, those instances in which, while a cachexia is certainly present, there is a hesitation, an accountable disinclination, or even an impossibility, in the way of pronouncing it anæmia, as that condition is ordinarily understood.

This leads me to offer some remarks on the special and peculiar conditions which are met with, the cardiac palpitation, and arterial pulsations, the bronchocele and prominence of the eyes. That these are, one and all, to be regarded as symptoms of the same disorder, does not, I think, admit of any doubt; and, further, I believe that the essence of the disease may be in existence without the association of all these symptoms. With the cardiac palpitation and arterial pulsations, and without the bronchocele or prominence of the eyes, it occurs; and, while the latter symptom is absent, the enlarged thyroid may, in some instances, be found. Clearly, and this view of the subject has a very important bearing on treatment, the cardiac and general vascular disturbance precede the thyroidal and ophthalmic symptoms, and, when properly recognised, by suggesting the employment of appropriate means may be said to prevent the appearance of the latter. The palpitation of the heart is, for the most part, the symptom which chiefly attracts the attention of the patient, and leads her to seek professional advice.[1] It is generally vehement, often it is tumultuous, always it is rapid, being precisely of the same nature, though usually more violent, as the palpitation with which we are familiar in ordinary instances of anæmia and chlorosis. That the excited action of the heart is, in the early stage of the disease, altogether independent of organic change admits of no doubt.[2] Again, the accounts of post-mortem appearances, in the fatal cases, which have been investigated by Sir Henry Marsh, Basedow, and Dr Begbie, satisfactorily prove that those changes which result from long-continued functional derangement of the heart are to be met with—chiefly permanent dilatation of its chambers, with more or less of hypertrophy. The cardiac disturbance being

[1] As is well known, the affection under consideration occurs more frequently in women than men; still, the observations of Dr Macdonell, Dr Begbie, Romberg, Henoch, and others, have shown that among the latter it can assume its most typical expression.

[2] I consider it quite unnecessary to advance any proof of the correctness of this statement. By some writers the heart affection has, indeed, been described as organic, and the sufferers from exophthalmos and bronchocele have likewise been regarded as the subjects of cardiac hypertrophy. Trousseau has specially addressed himself to the refutation of this error. But both Trousseau and Beau, the latter more especially, have admitted the existence in such cases of a temporary hypertrophy, "hypertrophie passagere," or rather a general dilatation of the whole cardiac chambers, such as the researches of Larcher, Ducrest, and Blot, have shown to occur during pregnancy. Muscular relaxation with flaccidity is a characteristic feature of anæmia—the involuntary muscular structure of the heart is just as likely to suffer as the voluntary muscles from the contact of impoverished blood.

admitted to be among the earliest of the morbid phenomena in this disease, the question presents itself,—upon what does this disturbance depend? That it is essentially neurotic in its nature may be admitted; such disturbed action of the heart as we thus find is probably best explained by interference with the cardiac plexus of nerves. That important network is formed by small branches from the pneumogastric, and by branches from the three cervical ganglia of the sympathetic; from the cardiac plexus styled great, and in which at least two ganglia are to be recognised, nerves proceed in intimate relation with the coronary arteries to the organ; into its substance they are to be traced, and they are there distinguished by possessing in their course minute ganglia, or nervous centres, which have not unreasonably been supposed to regulate the rhythmical movements of the heart. I conceive that the aberration of cardiac function, which interference with these ganglia best explains, may as readily and probably, on the whole, with greater probability of truth, be accounted for by their originally impaired nutrition, through an impoverished blood, than by the direct operation on them, or on more distant nervous centres with which they are intimately connected, of an injurious cause which cannot with any accuracy be defined,—chiefly spoken of as emotional. Healthy blood is the proper stimulus of the heart as well as of the vessels. Impure blood, unoxygenated, returning to the left side of the heart paralyzes the organ, and venous blood, too, stagnates in the pulmonary capillaries. This, indeed, is the primary phenomenon in asphyxia; the depressing influence exerted by such blood on the nervous centres succeeds its retardation in the lungs. A less deteriorated blood tells on the cardiac nerves, and through them the heart is excited to unrhythmical movements.

If now we turn to the consideration of the remarkable condition of the vascular system, I believe we shall there find, likewise, satisfactory evidence of its hæmic as well as neurotic origin. The palpitation of the heart is certainly not more characteristic than the violent pulsations of the arteries; it is chiefly in the neck that these are visible; the carotids beat tumultuously, and yield a very loud "bruit de souffle." When the hand is applied over the neck, or, still more, when both sides of the neck are held in the widely opened hand, the vibratory thrill or purring tremor from the carotids is remarkable. Of the cervical pulsations the patient complains; they are often most distressing to her, and are always greatly increased by muscular exertion. With them are associated a sense of fulness in the chest and head, throbbing in the temples, beating in the ears, vertigo, and dyspnœa. Severe dyspnœa, paroxysmal in character, I have only seen in one case, in which the bronchocele was of very large size, and must have in all probability interfered with the recurrent branch of the pneumogastric. Unquestionably all these distressing symptoms are likewise aggravated by emotional causes. Marked as the pulsation in the vessels of the neck, superficial as well as deep, is, it is not in these arteries alone that the movement is visible; if the larger superficial vessels at a greater distance from the heart are examined in characteristic examples of the malady, it will be found that they too are similarly affected—the brachial, radial, and ulnar of the superior, and the femoral, popliteal, and tibial arteries in the lower extremities. I have, moreover, known a patient to complain more of the *beating* in the belly than of either the cardiac or cervical pulsations, and have always found the abdominal aorta affected just as the other arteries of the body; distressing pulsation in the abdominal aorta is, indeed, of common occurrence in ordinary examples of anæmia and chlorosis. M. Beau has directed attention to the circumstance that, by writers generally on this disease, the radial pulse has been described as small, and states that he is unable to adopt a similar opinion.[1] The apparent smallness of the radial pulse is, however, due to the calibre of the artery; and, agreeing as I do with M. Beau in this observation, I believe that a juster view of the arterial pulsations will be formed, if the whole superficial arterial system be examined. Something, indeed, may be ascribed to the ready way in which an increased pulsation in the superficial vessels of the head and neck is recognised. Hippocrates, who was probably unacquainted with the doctrine of the pulse, nevertheless had noticed pulsation in the temporal arteries, Σφυγμὸς ἐν τοῖς κροτάφοις. I have further, in attending to this particular, determined that the synchronism between the heart's contraction and the distant pulses is more exact than in ordinary circumstances, and in this phenomenon, as well as in the exaggerated vascular motion, have recognised the increased energy of the heart's action excited to overcome the loss of assistance afforded by the rhythmical contraction of the arteries. In anæmia and chlorosis, increased pulsations of arteries, particularly the arteries of the neck, are not absent, and have long attracted attention. Felix Plater, whose description of cachexia has already been quoted, after speaking of various signs, remarks, "Accidente simul pulsatione arteriarum circum jugulum;" and Rondelet observes, "Noscitur pallidus color virginum, ex arterariarum colli pulsatione, et ex cordis palpitationibus." These writers are cited by M. Beau; and both he and M. Bouillaud, in their paroles before the Imperial Academy, have expressed the common experience of physicians when they said, that every day chlorotic girls ask our advice for palpitation of the heart and pulsations in the arteries, who believe themselves to be affected with some serious disease of the heart, and have already lost hope of recovery. As we have found the cardiac derangement to depend

[1] Dr Stokes has said on this point, "In most instances, we observe a want of proportion between the force of the pulsations of the arteries of the neck and those in other parts of the system. The carotid and thyroid arteries may pulsate with vehemence, so as to give the idea that all the vessels of the neck are enlarged and in a state of morbid activity, yet the radial pulse be small and weak, and only rapid or irregular according to the state of the heart's action."—Diseases of Heart and Aorta, page 281.

on a hæmic as well as neurotic cause, so I believe in the same way may the pulsations of the arteries be best explained. Allusion has been made to the supply of nerves to the heart; it is by minute branches from the same system that the bloodvessels throughout their most distant ramifications are embraced. The muscular apparatus, with its contractile property, chiefly resident in the small bloodvessels governing their diameter, receives no other nervous supply than from the sympathetic. Careful experiments have demonstrated the influence of the organic nervous system upon the calibre of bloodvessels both large and small. Those of Valentin and others, by which irritation of the sympathetic and the roots of the cervical nerves produced contractions in the aorta, and the still more important experiments of Waller on the former nerve in the neck, section, or ligature of which caused enlargement of the minute arteries, accompanied by elevation of temperature, while application of the galvanic stimulant for a brief period effected their contraction to the ordinary calibre. In the disease under consideration, there is first of all increased unrhythmical pulsation of bloodvessels, and ultimately permanent dilatation—the proof of the latter occurrence will be adverted to when I come to treat of the thyroidal enlargement and proptosis. That the influence of the vaso-motor nerves is perverted, and that from this cause results the irritation of bloodvessels, and ultimately the serious impairment of that structure in them by which through nervous energy the circulation is properly maintained, can scarcely be said to admit of doubt. The question is, whence arises this morbid influence? is it, as Dr Laycock has ingeniously endeavoured to establish, ganglionic, affecting certain central portions of the vaso-motory apparatus. There are certainly not wanting features in this most interesting disease which appear to lend support to this view; but it appears to me as still more probable that the influence is exerted chiefly on the nerves of bloodvessels themselves, and that just as in the affection of the heart already discussed, so in the bloodvessels it is the blood which operates injuriously on them. It is true that there are no direct experiments to establish the correctness of the view, that bloodvessels may be stimulated to contraction, and if so, the subsequent changes may be imagined,—directly through the medium of their own nerves. There are great difficulties in the way of such experiments, but at least there are no experimental observations which oppose the conjecture, and there are some facts which give it probability. Dr Carpenter sees no reason to doubt that by the sympathetic the impression of imperfectly-arterialized blood circulating through the systemic vessels may be conveyed to the spinal cord.[1]

There remain for consideration the bronchocele, and the remarkable appearance of the eyes. The enlargement of the thyroid gland, which is met with in such circumstances, varies very considerably as

[1] Principles of Human Physiology, page 273.

regards size, from a mere fulness, to a bronchocele of no inconsiderable dimensions. In its nature, likewise, there exists some variety dependent in great measure on the length of time during which it has existed. At first, it is very evidently the so-called vascular bronchocele,—the gland is occupied to a great extent by blood, the bloodvessels are distended, and the thyroidal arteries, like the carotids and other superficial trunks, pulsate more or less vehemently; the thrill or fremitus experienced, when the hand is placed over the tumour, is generally considerable. To the touch the bronchocele at this stage feels uniformly soft. Beneath the skin which covers it the superficial veins are seen unduly prominent and loaded. Suddenly, as in instances detailed by Dr Robert Taylor, the bronchocele may appear, ordinarily the swelling occurs gradually, often with considerable rapidity, always in succession to the derangement of the heart and bloodvessels already described. The bronchocele may disappear suddenly; while yet recent its size is readily affected by treatment; it has entirely disappeared in not a few instances. Nevertheless there is a manifest tendency to the swelling continuing permanent; when so, certain important changes are noticeable,—it has generally somewhat diminished, has become less vascular, not so pulsatile, and of denser consistence. Hypertrophy of gland structure, perhaps cystic formation, and permanent dilatation of bloodvessels, have in these cases resulted. In endeavouring to explain the occurrence of the vascular pulsatile bronchocele under such circumstances, assistance is obtained from attending to the normal structure of the thyroid gland, and, particularly, to the size and distribution of its bloodvessels. All anatomical descriptions of this body have reference to the remarkable vascularity which distinguishes it. A ductless gland presumed to be concerned in the process of blood elaboration, it is invested by a thin layer of dense cellular tissue, by which it is connected with adjacent parts, receives support to its vessels, and is imperfectly separated into vesicles of small but varying size. As to its bloodvessels, the thyroid gland is distinguished by their number, large size, and free inosculation. "In fact," says a recent anatomical writer, "it appears to be composed of a tissue of arteries and veins."[1] It has two and sometimes three independent sources of blood-supply, and the veins are equally numerous and large, forming a flexus upon it. Having, as Dr Begbie and other writers have already done, spoken of the bronchocele as vascular, and entertaining no doubt that the augmentation in bulk of the gland depends upon arterial and venous congestion, associated with dilatation of both sets of vessels in the more advanced stages of the malady, having witnessed sudden and very considerable increase in its size, and its visible pulsations redoubled in force, when the heart's action became excited, I explain the enlargement of the thyroid gland in such cases as are under consideration, by a reference to the number

[1] Holden's Manual of Dissection of the Human Body, page 16.

and size of its bloodvessels. Dr Laycock has, however, argued that, depending on nervous interference, the pathological condition is to be connected with a lesion of a special nervous centre. We know the sources of nervous supply to the thyroid gland: these are twofold,—from the laryngeal branch of the pneumogastric, and the cervical ganglia of the sympathetic. I do not know any circumstances in the cases of bronchocele we are considering which would certainly lead me to suppose that a particular definite portion of the nervous centres is the seat of lesion. On the other hand, recognising excited vascular action, and afterwards dilatation of arteries as well as veins, not limited to the thyroid gland, though well-marked in it, but seen more or less in the whole vascular system, I am led to believe that while the nervous system is certainly at fault, it is essentially the vaso-motor nerves in their intimate distribution to bloodvessels which are affected, that this is specially marked in the thyroid gland, because it is so extremely vascular; and again, that a hæmic origin as readily or better explains the phenomena, than the direct operation on the nervous system of some obscure cause. It may be objected to this view that bronchocele is of less common occurrence in connexion with anæmia than such observations seem to imply. Upon this point I would beg to remark that I have often noticed a moderate degree of vascular thyroidal fulness, in persons of both sexes, who, having lost blood, presented some appearance of anæmia. I lately saw a youth labouring under scorbutus, and who had suffered two attacks of epistaxis, one very severe; he was of anæmic aspect, had palpitations, general vascular pulsations, and a small bronchocele.

Anatomically, as regards its great vascularity and ductless nature, and physiologically, as in all probability concerned in the elaboration of blood, the spleen may be classed with the thyroid gland. An increase in size of the latter organ has been noticed in several instances of associated bronchocele and exophthalmos, and has been specially referred to by Sir Henry Marsh, Basedow, and Dr Begbie. In one case the spleen weighed twenty ounces, in other two it was found enlarged. Heusinger has particularly directed attention to the condition of the spleen, which he found after death much increased in volume, and manifestly diseased. I have been able in two well-marked examples of the disease to satisfy myself that the size of the spleen was considerably augmented.

Passing now to the consideration of the remarkable appearance presented by the eyes,—the so-called exophthalmos. It is well ascertained that in this disease there exists a degree more or less marked of prominence of the globes; that vision is little, often not in the least degree affected; that the feeling of fulness and tension, varying greatly as the heart's action, is comparatively calm or much excited, is not ordinarily attended by any visible redness or injection of the conjunctival or sclerotic membrane; that, except in very advanced instances of the disease, there is no interference with visual accommodation; that the eyes under gentle pressure can be caused to retreat into the orbits; and, lastly, that the pupils are, in their normal state, contracting on exposure to a bright light. Such has been the condition of the eyes and of vision in all the cases of this disease which have come under my own notice, and this description coincides with the statements of Dr Begbie and Dr Stokes, as well as those of Mr Walker, Dr Mackenzie of Glasgow, Dr Argyll Robertson, and other oculists. I have never seen in any case the least degree of squinting, even to so slight an extent as to depend on what may be called a want of tonicity of the ocular muscles, never ptosis, never nystagmus or twinkling of eyelids or eyeballs, or increased vascularity of the conjunctiva, or any corneal affection; nothing in short to indicate the existence of a lesion of the nervous centres, cerebral or spinal; nor have any of the patients who have come under my own care suffered from orbital neuralgia of any kind or degree. I seek, then, in the condition of bloodvessels the cause of the prominence of the eyes. A distended state of the ophthalmic vessels in all probability does exist. Increased vascularity of the choroid has been found by Graefe and Withusen, the latter of whom expressly states that a high degree of congestion of the vascular membrane of the eye is often combined with prominence of the eyeballs. The veins of the choroid are placed on the external aspect of the membrane, and are arranged in drooping branches, "vasa vorticosa." The arteries are found within, and form a very minute network, the "tunica Ruyschiana;" but with the dense sclerotica covering the choroid, it is inconceivable that the distention of these vessels can give rise to any great amount of ocular prominence. Nevertheless, in their congestion, and still more in that of the ophthalmic veins which, receiving many branches in their backward course, terminate in the cavernous sinus, it is not improbable that the cause of the proptosis exists. The congestion, however, just as in the congestion of the thyroidal vessels is determined by a nervous lesion—not, as I have already observed, a lesion of nervous centres—but by injury done to the "vaso motor" nerves themselves. Here, too, there appears to me no important objection to the view that the impoverished state of the blood is the original morbid cause acting on the nerves of bloodvessels; and it is remarkable with what uniformity the protrusion of the eyes has by oculists, at least, been regarded and styled anæmic. It is not fatal to this view that no congestion of the ophthalmic veins has been found invariably in such cases after death;—it has sometimes been found. Such an appearance does not continue long, the blood readily passes into other and larger trunks than the smaller veins which it had occupied before, and the adjacency of the veins to the sinus may account for its more rapid disappearance in the case of the ophthalmic veins. But the enlargement of veins has been frequently met with,—the jugular veins, the thyroidal veins, the vena cava inferior, these are all mentioned in different cases as having

been found greatly enlarged. The permanent dilatation is more likely to occur in veins than in arteries, for the former, while possessing essentially the same structure as the latter, have less of the true elastic tissue. That the dilatation of the veins in the neck, as well as in other parts of the system, may be in part due to the distending influence of an accumulation of blood in them, which in its turn results from a diminution in the influence exerted by the contraction of muscles on them is not improbable, we know that thereby the venous circulation is in considerable measure maintained, and if the blood be impoverished muscular energy will likewise suffer. This is, I think, a more probable view than that of Dr Marshall Hall, that the protrusion of the eyes was due to pressure on the veins, exerted by the muscles of the neck. Mr Walker has signified a modified assent to this view; but if the action of the muscles was moderate the venous circulation would be only maintained, and if violent, besides seeing the phenomenon, we should find, at least in some cases, the trachelismus of Marshall Hall produced;—this I never heard of. Dr Laycock having adopted another theory of the cause on which the protrusion of the eyes depends, has endeavoured to strengthen his position by a reference to the important experiments of Budge and Waller, and of Claude Bernard, on the sympathetic in the neck.[1] Interesting and important as these are, however, I do not see that they nor the more recent experiments of the last-named physiologist have any immediate bearing on the eye affection which is found in connexion with bronchocele. It is, in the first place, true that the former occurs, though that is very rare without the latter, and therefore the pressure of an enlarged thyroid on the cervical sympathetic could not explain the relationship when it did occur. This, however, while at one time the view entertained by Dr Laycock, has long been abandoned, and, founding on the experiments of the accomplished physiologists referred to, he has embraced the opinion and ably supported it, that there is a definite tract of the cord intimately connected with the ganglionic nervous system, which is the seat of lesion,—a tract which maintains through the sympathetic and cerebro-spinal ocular nerves a most important relation. This tract, too, is no doubt in connexion with the heart and bloodvessels in the neck, and hence may be assumed to arise their disturbance. I have already attempted to show that this explanation of the

[1] The late M. Aran, in endeavouring to explain the etiology of the exophthalmos associated with bronchocele, and cardiac, as well as vascular disturbance, had made full use of the important experiments of M. Claude Bernard, very specially attaching importance to the influence exerted by the sympathetic on the orbital muscle of H. Muller, the action of which is to carry the eyeball forwards. Dr Laycock, availing himself of still more recent experiments by the same physiologist (Recherches experimentales sur les Nerfs vasculaires et calorifiques du grand sympathique,—*Comptes Rendus*, 18 Août 1862), has ingeniously argued that heat is the proximate cause of the nervous and anæmic palpitations, pulsations, and thrills.—*Edinburgh Medical Journal*, July 1863.

cardiac and vascular excitement—and the latter includes the bronchocele—is unnecessary, and that the operation of an impoverished blood on the vaso-motor nerves of the sympathetic, at least as satisfactorily accounts for their implication; and I think, further, that there are grave objections to the view, that a lesion of the cerebro-spinal system, acting through the cervical sympathetic, determines the proptosis which we meet with in such cases as those now under consideration. In the cavernous sinus the sympathetic is connected by branches with the third, fourth, fifth, and sixth nerves, besides this, has, with two of these, the third and fifth, other important connexions, and itself governs the radiating fibres of the iris. Now, were the cilio-spinal region of the cord, "regio cilio spinalis," as Budge and Waller have styled it, or the sympathetic trunk in the neck, or any of its ganglia, the special seat of irritation, it may be inferred that some abnormal condition of the muscles, governed by the third, fourth, fifth, and sixth nerves, or an abnormal state of the pupil, which is under the control of circular fibres, receiving supply from the third pair and the fifth, and radiating fibres which filaments from the sympathetic govern, would have been found and described. Such, as already stated, has not been the case. Neither convergent or divergent squint, nor contraction, nor dilatation of the pupil, nor ptosis, have been noticed. That such conditions have been observed in some instances of proptosis is certain, but not in instances of the disease with which we are occupied. Petit's shrewd discovery, more than a century ago, that section of the united pneumogastric, and sympathetic in the neck affected the pupil; the queer gropings of Testa, forty years ago, half in the dark;[1] the philosophical conclusions drawn by the late Dr John Reid, respecting the influence of the sympathetic on the pupil; the brilliant experiments of Valentin, Budge, and Waller, and Claude Bernard, not less than the patient clinical observations of Dr W. T. Gairdner, Dr Walshe, Dr Ogle, and many others, have shown that there exists no more certain result of irritation of the cervical sympathetic, and very probably of the spinal centre with which it is connected, than a modification of the pupil.[2] One other nervous phenomenon I have noticed in cases of associated exophthalmos and bronchocele, namely, an exalted temperature, of which the patient herself often complains, not of face, or neck, or chest alone, but of general internal heat, sometimes experienced greatly in the feet: the dilatation of minute bloodvessels most satisfactorily explains this condition.

Before adverting to treatment, and mentioning certain general

[1] Delle Malattie del Cuore. See chapter ix. of 2d volume, entitled Della cecità, che talvolta sopravviene ad alcuni Cardiaci.

[2] It must be held in remembrance, as mentioned by Dr Argyll Robertson, that Dr Praël of Brunswick has found in three out of nine cases that the protrusion of the eye was unilateral, the right being the one affected—a circumstance which, while not directly lending support to the anæmic theory, does not, I admit, oppose the view of the proptosis depending on a lesion of nervous centres.

conclusions to which the foregoing observations seem to tend, I desire to communicate very briefly the history of two cases of vascular bronchocele with exophthalmos, which have recently come under my notice in the Royal Infirmary.

Case 1.—P. B., æt. 34, admitted into Ward 15, Royal Infirmary, 6th November 1862. Married nine years, and has had one child. Has for a long period suffered from scanty menstruation, with occasional intervals of total absence of the discharge. One of these intervals extended over a period of eleven months. Has enjoyed, on the whole, better health since her marriage than before it. For some months previous to February 1862, suffered from profuse leucorrhœa, and, after recovering from this, continued in a very weak state. In June had several profuse bleedings from the nostrils, and these attacks, though lessened in severity, have continued to occur till the present time. While so suffering, about June she began to have palpitation of the heart, from the first accompanied by buzzing noises in the head, and severe headache. About a month after the palpitation had commenced she observed a fulness about her neck, and, after the lapse of another month, her friends had remarked an altered expression and prominent appearance of the eyes. Throughout the summer has had frequent looseness of the bowels, and has noticed that the stools often contained portions of undigested food. Has latterly become very nervous and depressed in spirits.

On admission, the patient has a decidedly anæmic appearance; the eyes have a prominent aspect, and peculiar wild expression ("expression sauvage" of French writers); the eyes feel hot and tense to the patient, but her sight is unaffected; there is no peculiarity about the pupils, or the muscular apparatus of the eyeballs or eyelids, no orbital œdema. There is a bronchocele of considerable size, more prominent to the right than left side of neck, and much pulsation in the thyroidal and carotid arteries; the jugular and thyroidal veins appear distended. With the stethoscope a loud blowing sound closely synchronous with the systolic action of heart is audible, and when the hand is applied over the tumour a distinct thrill is distinguished. The heart's action is much excited—the beats 120 per minute—the rhythm altered considerably and variously. Region of precordial dulness not extended; soft blowing murmur, with first sound at base; loud bruit de souffle in the arteries of neck, arms, and lower limbs; very loud in abdominal aorta, the pulsation of which is readily seen, and proves distressing to the patient. She is easily agitated, and now somewhat desponding.

In this patient's case I had the first opportunity of combining the general regiminal treatment and the use of iron, as recommended by Dr Begbie, with the employment of belladonna. After the application of a large plaster of belladonna, for a few days, a very marked diminution in the size of the bronchocele, and a sensible amelioration in the condition of the eyes, had resulted.

While the application of the plaster was continued, I prescribed atropia internally, in doses of one-sixtieth of a grain, morning and evening, only interrupting its administration when a complete dilatation of both pupils had resulted, and the patient was unable to read.

Greatly improved in health, this woman left the hospital a little after Christmas. I have seen her twice since that time. On the last occasion, only a few days ago, when availing herself of an excursion by train from the part of the country where she resides, she came to town. I found the eyes normal; the bronchocele still existing, but not as a vascular bronchocele; a small firm tumour alone remained, while cardiac palpitation and vascular pulsations have vanished. Her appearance is no longer anæmic, and, twice since she left the hospital, menstruation has taken place.

This is in every respect a favourable case. Treatment was employed at an early period, and speedily produced a beneficial effect. In cases distinguished by the continuance of the characteristic symptoms for a much longer time, so successful a result is scarcely to be anticipated. That a relapse may possibly occur is not to be questioned; but familiar as I am with one of the earliest cases recorded by Dr Begbie, in which a perfect cure has resulted, and now at the end of fifteen years continues, I am disposed to think that such an occurrence is unlikely.

Case 2.—Mrs ——, æt. 37, mother of seven children, with her strength greatly reduced from nursing an infant of thirteen months, and repeatedly a sufferer from menorrhagia. Anæmic in appearance; has a considerable bronchocele, and in a marked degree the peculiar prominence and expression of the eyes. These symptoms have developed themselves within the last two months. Is not nervous. The beating of heart and arteries, and the auscultatory phenomena connected with these, are precisely as in the former case. This woman states positively that she never sustained any sudden shock, or mental distress of any kind.

After a few weeks' treatment the patient has greatly improved under the use of iron, with belladonna prescribed in the same manner as in the case already detailed.

The plan of treatment pursued in these cases and in others which have come under my care has had reference, firstly, to calming the excited action of the heart and bloodvessels; and, secondly, to improving the evidently deteriorated condition of the blood. I believe that in order to remedy the disorder both of these indications must be met, the one without the other will fail. Belladonna is a powerful excitant of bloodvessels, acting on the unstriped muscular fibres in them. The experiments of Brown-Séquard upon animals have sufficiently established this point. Again, as a remedy, belladonna is known and prized from its possession of this very property. Acting in all probability on the bloodvessels of the iris, it causes dilatation of the pupil, on the bloodvessels of the mamma

it arrests the secretion of milk, on the muscular coat of the intestine action of the bowels. Administered in the form of its extract, in doses of one-sixth or one-fourth of a grain, or as atropia, in doses of one-sixtieth, or applied as a plaster over the enlarged thyroid gland, I have found this remedy to produce speedily a remarkable effect on the eye, in causing its retirement and in removing the peculiar staring expression; on the thyroid gland, in leading to the rapid, or at all events speedy diminution in its bulk; on the heart and bloodvessels in modifying and controlling their excited action. I cannot doubt that in producing these effects its special action is exerted on the dilated vessels, stimulating them to rhythmical contractions, and thus overcoming congestions. It is from its action in this way that the late Professor Schroeder van der Kolk found belladonna so useful a remedy in epilepsy,[1] and that Brown-Séquard has satisfactorily tested its claims to employment in cases of paraplegia dependent on congestion of the cord or chronic inflammation.[2] But while belladonna, and specially atropia, produce these effects, and thus greatly modify the distressing symptoms in such cases, unaided neither will accomplish a cure. Iron, as the "summum remedium" in blood impoverishment, must be administered, and that steadily for a time. Thus combined, I think, in comparatively recent cases, the most desirable results will speedily be obtained. Dr Begbie had found iron in combination with henbane, a plant belonging to the Atropaciae, and exerting some properties similar to belladonna, most serviceable; and before I was led to employ the latter, I always used the tincture of hyoscyamus with the tincture of the muriate of iron. Trousseau has employed digitalis, and speaks with confidence of the remedial virtues of cold compresses when applied over the thyroid gland. The operation of the latter is evidently directly on the vaso-motor nerves, and leads to a sympathetic contraction of bloodvessels in other parts. Iodine is not only useless as a remedy in this form of bronchocele, but, as M. Beau and others have shown, positively injurious. None of those means which are ordinarily employed with benefit in the treatment of blood impoverishment, associated with more or less of nervousness or hysteria, should be neglected,—advantage is certainly to be derived from change of air and scene; but, on the other hand, the disease is emphatically one requiring for its relief the continued use of such remedies as have been referred to. It has been noticed by some writers that when a woman affected with this peculiar disease becomes pregnant, a manifest improvement in her condition occurs—a circumstance only to be explained by the change which takes place in the condition of the blood while

[1] On the Spinal Cord and Medulla Oblongata, and on the Proximate Cause and Rational Treatment of Epilepsy.—New Sydenham Society's edition, page 275.

[2] Lectures on the Diagnosis and Treatment of the Principal Forms of Paralysis of the Lower Extremities. 1861.

pregnancy exists, and pointing, therefore, to the hæmic origin of this complex malady.

I am, therefore, disposed to conclude,—that the true pathology of the bronchocele and exophthalmos, found in connexion with cardiac palpitation and vascular pulsations and dilatations, lies both in the blood and in the nervous system, but that the "primum mobile" is the former;—that an altered state of the blood—for a time stopping short of what is generally known as anæmia,—but in many cases amounting to well-marked anæmia, acts directly on the nerves of bloodvessels, and on the nerves of the heart—"Sanguis moderator nervorum;"—that, as a consequence, their rhythmical movements are seriously affected, and dilatation of the heart's chambers, and of bloodvessels, arteries, but chiefly veins, results;—that for a lengthened period the bronchocele is truly a vascular enlargement and dilatation; but that, in course of time, hypertrophy and degeneration of gland-structure result;—that the exophthalmos, which is not a necessary consequence any more than the bronchocele of the disordered state of blood, and neurosis of bloodvessels, depends upon congestion and vascular dilatation of the ophthalmic vessels, with effusion of serum into the post-ocular cellular tissue;—and, lastly, that a plan of treatment directed to the improvement of the condition of the blood, and, at the same time, to the state of the nervous system,—is successful in effecting a cure, provided those organic changes in the heart, to which reference has been made, have not already been induced.

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ON THE DEVELOPMENT

OF

TORULÆ IN THE URINE,

AND ON

THE RELATION OF THESE FUNGI

TO

ALBUMINOUS AND SACCHARINE URINE.

BY

ARTHUR HASSALL, M.D., Lond. M.R.C.P.

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PART I.

BEFORE proceeding to offer any remarks of my own on the subject of the present communication, I propose to place before the Society the opinions and observations in relation to torulæ in urine, entertained and recorded by others up to this time.

"Diabetic urine," writes Dr. Griffith,[1] "if left in a warm place, becomes covered with a frothy white layer, as if its surface had been sprinkled with flour. This is quite characteristic, and when once seen cannot be mistaken. This white froth is composed of a number of minute vegetable organisations, which have been denominated *torulæ;* they occur in all fermenting liquids, and their growth is by some considered, in relation to fermentation, in the light of cause and effect. They are figured in pl. ii, fig. 35; their development is very interesting. When first formed they are very minute spherical globules, composed of two coats, and filled with a liquid containing in suspension a number

[1] Practical Manual, pp. 49, 50.

of extremly minute granules; the globules enlarge, rise to the surface, and form the white scum. Some of the internal granules also enlarge, and become distinct nuclei. These continue expanding, the primary globule becomes elongated, and one of the enlarged nuclei bursts through the envelopes of the maternal cell and appears as a bud; this enlarges, others increase in the same manner. As the globules enlarge they become elongated, finally forming long, slender, jointed vegetables, as in pl. ii, fig. 35. These contain several nuclei, which are ready to bud out in the same manner as their parents have originally done. They seem to increase in two distinct ways: one is the budding process above mentioned, the other is the division of the parent cell. It is first divided by the increase of two, three, or more nuclei into as many separate parts. It then becomes contracted opposite the spaces between the continuous extremities of the internal young cells, finally forming distinct and independent plants, capable of further propagation in a similar manner."

Under the head of Torulæ in Diabetic Urine, Dr. G. O. Rees states,[1] "This fungoid vegetable growth, which is delineated on the plate, fig. 15, is characteristic of the existence of fermentation, and its presence may be regarded as a very correct microscopic test of the presence of sugar."

Dr. Golding Bird[2] gives the following account of "Torulæ" in saccharine urine:—"It is well known that in all saccharine fluids undergoing the alcoholic fermentation, minute confervoid, or fungoid vegetations, called torulæ, appear, and pass through certain definite stages of development. There is, indeed, considerable reason to believe that these vegetations bear to fermentation the relation of cause and effect. The arguments lately advanced by Professor Liebig, in opposition to this opinion, do not, to my mind, afford a satisfactory answer to the observations previously made on this subject.

"When urine contains but very small portions of sugar,

[1] Analysis of the Blood and Urine, 2d edit., p. 217.
[2] Urinary Deposits, 2d edit., p. 289.

no means diagnostic of saccharine urine, although they form very soon and very plentifully in diabetic urine. In making this statement, however, Dr. Jones does not adduce the reasons which have led him to adopt this view; the opinion, however, as we shall see hereafter, follows as a necessary consequence from the inquiries of MM. Andral and Gavarret, on the development of penicilium glaucum in acid albuminous fluids.

Dr. Jones likewise states that, "If this vegetation is met with in the urine, we may immediately conclude that albumen exists in solution, and that heat and nitric acid will certainly confirm the truth of your opinion."

There is therefore a very considerable discrepancy of opinion as to the value of the torulæ test as an indication of sugar in the urine.

I will now proceed to record the results of my own observations on the Development of Torulæ in Urine.

I set aside, in the first place, at different periods, a considerable number of samples of non-saccharine urine of all kinds; some of these were acid, others alkaline, a few contained albumen, but the majority were non-albuminous. The changes which ensued in the several samples were observed and registered from day to day. In a large proportion of the samples torulæ quickly became developed, while in others they did not appear at all; they presented many distinct appearances and conditions of development, all of which, after a time, however, were ascertained to belong to, and to be characteristic of, one and the same species of fungus, of which the following is a description. Three distinct stages in the development of this plant may be recognised, each of which we shall describe separately under the heads of sporules, thallus, and aërial fructification.

Sporules.—Of these two kinds exist.

The *first* make their appearance in urine at an early period, usually in the course of a few hours, the precise time is determined, however, by the nature of the urine and the temperature of the weather; they are first visible as innumerable minute vesicles or cells, of a perfectly globular form, reflecting, when seen with an object-glass of one fourth of an inch focus, bright centres and dark outlines, and presenting a tolerably uniform size; when viewed, however, with a glass of one eighth of an inch focus, the shaded outlines nearly disappear, and the sporules are then observed to present considerable differences of size, from the [illegible]th of an inch in diameter to the [illegible]d of an inch; the larger all include a vesicular nucleus, sometimes placed in the centre of each sporule, at others it is eccentric; but the smaller sporules are not nucleated, and resemble in size and appearance the nuclei of the larger sporules; the cavities of all are occupied by a fluid containing granules. (Pl. I, fig. 1.)

In a short space of time, generally in a few hours, the sporules multiply to such an extent as to form, first, distinct circular patches and afterwards a continuous scum on the surface of the urine, as contained in a bottle or glass. In this scum the sporules are not heaped up over each other, but form a delicate stratum, constituted of a single layer of sporules, which, while they evidently repel the water, yet adhere to each other. Sometimes the patches, although small, cease to grow; in other cases they extend, until they touch each other, and from being circular become angular from mutual compression, the several patches yet remaining distinct; very frequently, as soon as they touch each other, they run together and form a continuous stratum, as noticed above: this may remain, as indeed it often does, without undergoing further change, or it may become wrinkled, or thrown up in a waved manner; both these appearances arise from the extension of the single layer of sporules, which having covered the entire surface of the urine, and being unable to spread itself out further, becomes variously folded or plaited. In general, the patches, whether small or large, are thin, delicate, transparent, and film-like; but in some cases they appear dry and white, resembling flour; upon what this difference depends I am not clear, but I believe it is connected with the amount of phosphates present. It is in this latter state that the surface of the urine presents the powdery aspect considered by so many

too little even to affect its specific gravity materially, or to cause it to assume a diabetic character, certain phenomena are developed connected with the production of the vegetation of the genus torulæ or saccharomyces, which will at once point out the presence of sugar. These indications are of very great value, as a saccharine condition of the urine is not uncommon in dyspepsia and some other affections, and is, of course, of the highest importance in directing our treatment.

"When saccharine urine is left in a warm place, a scum soon forms on its surface, as if a little flour had been dusted upon it. This consists of minute oval bodies which soon enlarge from the development of minute granules visible in their interior. These continue expanding, and dilate the oval vesicle containing them into a tubular form; soon afterwards the internal granules become larger and transparent, and project from the exterior of the parent vesicle-like buds. The whole then resembles a jointed fungoid or confervoid growth, which ultimately breaks up, and a copious deposit of oval vesicles or spores fall to the bottom. All these stages of development, fig. 46, require but a few hours for their completion. If the deposited spores be placed in weak syrup, they rapidly germinate, and exciting fermentation, produce a new crop of torulæ. During the growth of the torulæ, bubbles of carbonic acid gas are evolved, and the urine at length acquires a vinous odour, sometimes accompanied by an odour of butyric acid. There are two kinds of urine which may be mistaken for saccharine, by the occurrence of a kind of fermentation not unlike that of fluids really containing sugar. I refer to the form of viscous fermentation which occurs in urine, and ending in the appearance of much ropy mucus. This has occurred to me repeatedly in specimens of urine containing cystine, the odour evolved being, however, disagreeable and sulphurous, quite distinct from the vinous odour of the alcoholic fermentation. Somewhat similar phenomena are occasionally presented by the urine of persons exhausted in health from scrofulous or syphilitic cachexia."

"Torulæ," observes Dr. Bence Jones,[1] "are by no means diagnostic of saccharine urine; but though they form very soon and very plentifully in diabetic urine, yet they may be constantly found in urine which contains no trace of sugar; and though they may lead you to look for sugar, they must never lead you to assert that sugar is certainly present in the urine in which they occur."

In his 10th Lecture on Albuminous Urine,[2] Dr. Jones also makes the following remarks:—

"There is a peculiar microscopic appearance in acid albuminous fluids to which M. Andral has directed attention. In the 'Annales de Chemie,' vol. lxxxiii, p. 385, there is a paper on the development of the penicilium glaucum, under the influence of acidification, in the albuminous fluids of health and disease, by MM. Andral and Gavarret. Serum of the blood diluted with twice its volume of water, and acidified by dilute sulphuric acid, usually, in twelve hours, gave vesicles, which elongate rapidly, forming a long, branching, jointed vegetable, of which drawings are given in the different stages of its development; albumen and acid are necessary for its growth: if, therefore, this vegetation is met with in the urine, we may immediately conclude that albumen exists in solution, and heat and nitric acid will certainly confirm the truth of your opinion."

The above observations comprise nearly all the information contained in the writings of English authors in reference to torulæ in the urine.

It appears then, from these extracts, that Drs. Griffith, G. O. Rees, and G. Bird, on the one side, regard the development of fungi in urine as affording a very valuable and decided test of the presence of sugar, the latter observer even considering it to be so delicate as to be capable of detecting such small portions of sugar as are too little even to affect the specific gravity of the urine materially, or to cause it to assume a diabetic character.

On the other hand, Dr. Jones states, that torulæ are by

[1] On Animal Chemistry, p. 121. [2] Loc. cit., pp. 109-10.

Now the thallus is met with in urine in two states,—it either forms patches on the surface, or one continuous stratum, these states depending upon the number and distribution of the sporules which precede it. As is the case with the sporules, the development of the thallus may be arrested at any stage of its growth.

When this happens, it soon breaks up and dies; before the breaking-up of the threads occurs, however, I have frequently observed the granular and vesicular contents of the filaments to collect into little rounded or oval masses, which escaping through the common investing sheath of the threads, become so many sporules. When in a mass of thallus, some filaments are seen transparent and destitute of contents, while others contain little rounded or oval bodies; and when a large number of sporules are lying about intermixed with the threads, we know that this elimination of sporules has occurred.

Every perfect fungus developed in a fluid consists of two parts, an aquatic and an aërial. The thallus represents the aquatic portion, and the filaments of which it is formed readily imbibe the fluid in which they are immersed; on the other hand, the stems and sporules which form the aërial portion of the fungus, repel the water and manifest an affinity for the air.

The last stage, then, in the development of the fungus, is that of aërial fructification:

Aërial Fructification.—After the lapse of a still further time, a mouldiness appears on the surface of the already-formed thallus. This follows exactly the distribution of the thallus itself; if it be in patches, then the mouldiness will appear only in places on the surface of the urine; but if the thallus form a continuous stratum, the mould or mildew will do the same.

The mould or aërial fructification presents the following structural peculiarities:—

If the surface of the thallus be carefully examined sometime previous to the appearance of the mould or fructification, a number of short upright stems or threads will be observed.

Each vertical stem having attained a certain height, divides into one or two branches, each of which becomes subdivided into several other very short and slightly moniliform branches,—thus a tuft or head is formed; at the extremity of the several branches rows or strings of circular bodies appear; these, on the slightest movement, become detached from the head, and fall either on the thallus or into the water (Pl. IV, fig. 2); now these circular bodies are identical with the sporules first described, and each represents a separate plant. It is in these sporules that the glaucous green colour so characteristic of this fungus in its perfect state of development is located; the colour varies, however, greatly in different cases; sometimes the patches or stratum of the fungus possess scarcely a tinge of green, at others they are not in the least green, but of a fawn colour; lastly, in some cases in which the spore-bearing heads are not formed at all, the vertical threads, upon which when present they are supported, become considerably elongated, and then the patches resemble pieces of white wool.

Such is a short sketch of the development of this fungus in its different stages; it is to be observed, however, that the several conditions described do not always keep separate from each other; thus, frequently, the sporules and thallus coexist, and in some cases we find sporules, thallus, and fructification, all more or less mixed up together; in certain urines, successive generations even of sporules may be seen passing through the several phases of their development.

It has already been stated that the growth of this plant, from a cause to be mentioned presently, is frequently arrested at any one stage of its development; but this is not all, for soon afterwards it begins to decay, and finally disappears from the urine; the only trace of its presence remaining is a deposit of sporules, circular in form, but irregular in size, and situated at the bottom of the urine. After the plant has once attained its full development, however, many days must elapse before its total destruction and disappearance.

We will now conclude this description by a few remarks on the propagation of this fungus.

observers as characteristic of saccharine urine. The smaller patches are usually, but not always, composed of the rounded sporules above described; sometimes the sporules have lost their spherical form, and this is almost constantly the case in the larger patches, and elongating slightly, become oval. (Pl. I, fig. 2.)

The elongation of the sporules is not constant, for sometimes the development of the fungus ceases with the formation of the globular sporules. This change of form occurs when the condition of the urine is such as to favour the growth of the fungus; under such condition the sporules quickly extend themselves, and become three or four times longer than broad, when they resemble short threads of nearly equal diameter (Pl. I, fig. 3), having rounded extremities; after a time, the sporules becoming still further elongated, pass into separate filaments, which consist of cells placed end to end, and all enclosed in a common transparent membrane; the threads are more or less curved, and increase in length sometimes by the extension of both extremities, but usually only of one, which is distinguished by its smaller diameter.

From this condition, which is frequently attained on the second or third day, the fungus passes into the higher state of *thallus*. (Pl. IV, fig. 1.)

The *second* kind of sporules, which for the sake of distinction I shall call *vesicles*, are many times larger than the ordinary sporules; their surface is frequently hirsute, like the pollen granules of the compositæ; they are globular, and from each proceed one, two, or three buds or shoots, which gradually extend into filaments, at first simple and afterwards branched, thus forming, as the sporules did in the previous case, the thallus.

Now while the ordinary sporules during growth are merged entirely into and lost in the filaments, the vesicles remain as prominent swellings or enlargements on the threads, not unfrequently increasing in size with the growth of the threads themselves. When the vesicles give origin to but a single filament, they are seen as terminal inflations; when to two or more, they of course are situated in the midst of the ramifications which have emanated from them. (Pl. 1, fig. 4.)

The number of vesicles present varies greatly in different cases: in general, the ordinary sporules alone are met with; in others a few vesicles only occur mixed up with the common sporules; in others, the number of vesicles has been considerable; and again in a few rare cases, I have detected vesicles only in a state of germination.

Of the sporules and vesicles we shall shortly have to speak again.

Now in some urines the growth of the fungus goes no further than to produce the sporules and vesicles; at this point, and even at any stage, all development not unfrequently ceases. The cause of this singular circumstance will be explained hereafter.

We will now pass on to the description of the thallus.

Thallus.—The thallus, then, it appears, takes its origin either in the sporules or vesicles. The filaments or threads, at first simple, which proceed from these, afterwards become branched, and the myriads of threads developed interlace together. It is therefore a compound structure, made up of innumerable perfectly distinct plants, which are held together simply by the interlacement of the filaments.

Like the sporules, it forms a layer upon the surface of the urine often of considerable thickness, several days being usually required for its complete formation. The growth of the thallus takes place principally from the extremities of the filaments; these mostly lie the deepest in the fluid, and it is near the extremities also that the branchings are most numerous, and therefore best seen.

The filaments forming the thallus are comparable to the roots of higher plants, and they extend themselves for some distance through the fluid in which they are developed in search of the nourishment by which the fungus is sustained.

The cavities of the jointed and branched filaments, like those of the vesicles and sporules, are filled with granular and vesicular material.

Its perpetuation appears to be provided for in several ways.

First.—By the sporules thrown or pinched off, as it were, from the reproductive tufts, and which therefore appear to be nothing more than definite and minute portions of the mother plant, each being endowed with independent vitality and capability of reproduction.

Second.—By the generation of secondary sporules within the cavities of the primary or first-formed sporules.

Third.—By the granular and vesicular matter which occupies the cavities of the filaments and cells forming the thallus; in these cavities circular bodies resembling somewhat sporules, but much smaller, may be seen, and it is probable that it is by their means that the species is perpetuated in those cases, of very frequent occurrence, in which the plant has been destroyed before attaining its full development.

Fourth.—By vesicles; these I regard as sporangia, analogous to the vesicular bodies, met with in the tribe of algæ, as parent-cells in fact, containing a number of germs.

The vesicles or sporangia are not confined to this one species, but are frequently to be met with in many other fungi, some belonging even to distinct genera.

Two other facts connected with the development of this fungus yet remain to be mentioned.

The first is, that it will develope itself with nearly similar facility, and in the same quantity, in urine passed directly into a new bottle and immediately corked, as in urine exposed to the air.

The second is, that sporules and even filaments may be detected in some urines almost immediately after they have been passed; from this it becomes probable that the development had commenced even in the bladder itself.

We have now to enter upon the consideration of the conditions necessary to the development of this fungus. The first step which I took with a view to determine what these conditions are, was to put aside in bottles, all corked, a variety of urines, fixing the dates to each, and noting from time to time the changes which ensued; the results of this proceeding are given in the following table:—

1st Sample:—*Aggravated Dyspepsia.* Urine very acid, non-albuminous, passed 24th August; on the 28th inst., a scum of circular sporules appeared; on the 2d of September, there was much of the fungus fully developed, with a few spherical sporules; on the 5th inst., the fungus was in the same state.

2d Sample:—*Chlorosis,* with œdematous feet. Urine acid, passed on 17th of August; on the 20th inst., a scum of spherical sporules became visible; on the 2d and 8th of September, the sporules were in the same state.

3d Sample:—*Dyspepsia.* Urine alkaline, non-albuminous, passed on the 22d of August; on the 24th inst., no sporules; on the 2d of September, no sporules.

4th Sample:—*Disease of Liver,* Anasarca. Urine albuminous, alkaline, passed on the 19th of August; on the 23d inst., no trace of fungus; on the 2d of September, still no fungus.

5th Sample:—*Dyspepsia.* Urine somewhat, but not strongly acid, non-albuminous, passed on the 17th of August; on the 20th inst., a few oval sporules; on the 2d of September, a scum of spherical sporules; on the 8th inst., sporules in same condition.

6th Sample:—*Disease of Kidneys,* Anasarca. Urine albuminous, decidedly acid, passed on the 23d of August; on the 27th inst., a scum of elongated sporules and filaments; on the 2d of September, a thick and continuous stratum of the fungus fully developed.

7th Sample:—*Disease of Kidneys.* Urine albuminous, feebly acid, passed on the 17th of August, examined on the same day, sporules with a few short filaments were visible; on the 20th inst., a few sporules, circular; on the 2d of September, sporules in the same state.

8th Sample:—*Articular Rheumatism.* Urine somewhat acid, non-albuminous, passed on the 18th of August; on the 20th inst., an incipient scum of spherical sporules; on the 2d of September, a very dense film of oval sporules; on the 8th inst., sporules in same condition.

9th Sample:—*Chorea.* Urine passed on the 28th of August, not very acid, non-albuminous; on the 2d of September, a dense scum of spherical sporules; on the 14th inst., scum on surface of urine all gone, a few sporules irregular in size, at the bottom of the bottle.

10th Sample:—*Phthisis.* Urine decidedly acid, slightly albuminous, passed on the 2d of September; on the 8th inst., spherical sporules abundant, with much fungus in a state of perfect fructification.

11th Sample:—*Dyspepsia.* Urine neutral, non-albuminous, passed on the 2d of September; on the 8th inst., no sporules.

12th Sample:—*Fever.* Urine feebly acid, non-albuminous, passed on the 19th of September; on the 20th inst., a few spherical sporules; on the 28th inst., the same; on the 2d of October, no increase in the number of sporules.

13th Sample:—*Inflammation of Kidney.* Urine non-albuminous, acid, passed on the 21st of August; on the 26th inst., a scum of spherical sporules; on the 2d of Sept., sporules much elongated; on the 8th inst., fungus in same state.

14th Sample:—*Disease of Kidneys,* Anasarca. Urine neutral; albuminous, passed on the 16th of August; on the 20th inst., no fungus; on the 2d of September, none.

15th Sample:—*Typhus.* Urine alkaline, non-albuminous, passed on the 24th of August; on the 30th inst., no fungus; on the 2d of September, none.

16th Sample:—*Fever.* Urine feebly acid, non-albuminous, passed on the 20th of August; on the 23d inst., powdery patches of circular sporules; on the 2d of Sept., a few sporules only.

17th Sample:—*Aggravated Dyspepsia.* Urine somewhat acid, non-albuminous, passed on the 16th of August; on the 20th inst., a scum of spherical sporules; on the 2d of

September, a dense film of sporules; on the 8th inst., sporules in same state.

18th Sample:—*Congestion of Liver.* Urine decidedly acid, non-albuminous, passed on the 21st of August; on the 26th inst., a scarcely perceptible scum of spherical sporules; on the 2d of September, sporules still circular; on the 8th inst., a patch or two of thallus.

19th Sample:—*Disease of Brain.* Urine alkaline, non-albuminous, passed on the 21st of August; on the 24th inst., no sporules visible; on the 2d of September, none.

20th Sample:—*Dyspepsia.* Urine alkaline, non-albuminous, passed on the 17th of August; on the 20th inst., no fungus; on the 2d of September, none.

21st Sample:—*Fever.* Urine alkaline, non-albuminous, passed on the 28th of August; on the 30th inst., no fungus; on the 2d of September, none.

22d Sample:—*Typhus.* Urine alkaline, non-albuminous, passed on the 19th of August; on the 23d inst., no fungus; on the 2d of September, none.

23d Sample:—Urine acid, non-albuminous, passed on the 16th of August, at night; on the morning of the 18th inst., sporules appeared, some oval, others elongated; on the 20th inst., a dense scum of oval sporules and filaments; on the 2d of September, fungus in same state; on the 8th inst., still in the same condition.

24th Sample:—*Phthisis.* Urine very acid, non-albuminous, passed on the 21st August; on the 2d of September, a scum of oval sporules; on the 8th inst., fungus fully developed.

25th Sample:—Urine strongly acid, non-albuminous, passed on the 28th of August; on the 30th inst., an abundance of spherical sporules; on the 8th of September, a continuous scum of fully-developed fungus.

26th Sample:—Urine acid, non-albuminous, passed on the 17th of August; on the 22d inst., spherical and oval sporules; on the 2d of September, a dense scum of circular sporules; on the 8th inst., sporules in the same state.

27th Sample:—Urine acid, non-albuminous, passed on the 19th of August; on the 22d inst., a thick scum of spherical sporules; on the 2d of September, sporules in the same state; on the 8th inst., sporules less numerous, many having sunk to the bottom.

28th Sample:—*Typhus.* Urine feebly acid, non-albuminous, passed on the 18th of August; on the 20th inst., a few somewhat oval sporules; on the 2d of September, sporules in the same state.

29th Sample:—Urine strongly acid, non-albuminous, passed on the 4th of September; on the 8th inst., circular sporules, with patches of fully-developed fungus.

30th Sample:—Urine strongly acid, non-albuminous, passed on the 4th of September; on the 8th inst., sporules and filaments of fungus; on the 14th inst., fungus in perfect fructification.

31st Sample:—*Phthisis.* Urine acid, non-albuminous, passed on the 30th of August; on the 8th of September, a scum of spherical sporules; on the 12th inst., no further development of the fungus.

32d Sample:—Urine acid, non-albuminous, passed on the 30th of August; on the 8th of September, a scum of spherical sporules; on the 14th inst., sporules in the same state.

From an analysis of the above table it appears therefore—

1st. That the fungus was developed in twenty-four out of the thirty-two urines submitted to examination.

2d. That in thirteen samples the development did not proceed beyond the sporule-stage.

3d. That in two it was arrested when in the condition of thallus.

4th. That in the remaining nine urines, it attained its perfect state, viz., that of aerial fructification.

5th. That those urines in which the fungus made its appearance, were invariably more or less acid, the degree of development varying with the acidity.

6th. That those urines in which it failed to make its appearance, were either neutral or alkaline, or though acid when passed, very quickly became first neutral and then alkaline.

7th. That the fungus appeared alike in albuminous and non-albuminous urines, provided these were sufficiently acid.

The frequency of the presence of this fungus in the urine is thus clearly established. One of the conditions necessary to its development, as we have seen, is an acid state of the urine; the degree of acidity and the length of time during which the urine remains acid, regulating to a considerable extent the growth of the plant. When the acidity is great, and of some days' duration, other causes being favorable, the fungus is enabled to pass through all the stages of its development, and to reach the state of mould or perfect fructification; when, on the other hand, the acidity is but feeble, the growth proceeds but slowly, and ceases entirely at whatever stage it may happen to have attained on the passing of the urine from an acid to an alkaline condition, and which, as appears from the Table above given, very frequently occurs when the fungus is still in the first stage of its development, that of circular sporules.

As is also shown by the Table, for some days after the urine has ceased to be acid and has become alkaline, the fungus does not appear to undergo any material alteration, but at length it begins to decay, and finally disappears.

The condition of development of this fungus in any urine is therefore, to some extent, an indication of the degree of acidity once possessed by that urine; it must be remembered, however, that although this plant is never developed in alkaline urine, it is yet sometimes present in it, the urine having been in the first instance acid, and having become alkaline subsequently.

We have now to seek for other conditions necessary to the development of this fungus.

When it is remembered that fungi contain nitrogen in their composition, and when their constant association with dead or diseased organic matter is called to mind, the idea that the presence of the species under consideration in the urine is closely connected with the animal matter contained in that fluid will at once appear as highly probable.

Now, animal matter, and even albumen, as in mucus and epithelium, are constantly present in the urine in greater or less amount, the albumen being contained in the epithelial scales and mucous cells; and hence this fluid ordinarily supplies another of the conditions requisite for the growth of this fungus.

With the view to ascertain whether the notion just referred to was correct, I procured a number of urines. I divided each sample into two portions, one was carefully filtered so as to remove at least part of the animal matter, the other was allowed to remain just as it was passed; the whole of the samples were set aside in corked bottles, and examined from time to time. The results obtained by this proceeding were as follow:—

1st Sample:—Urine passed on the 13th of September; on the 20th inst. there was a very decided scum of sporules upon the surface of the unfiltered urine, but none upon the filtered; and on the 22d inst., still no appearance of fungus upon the surface of the latter.

2d Sample:—Urine passed on the 13th of September; on the 17th inst. a thick scum of sporules upon the unfiltered, but none upon the filtered urine; on the 22d inst. fungi on both, but the layer thickest on the unfiltered portion.

3d Sample:—Urine voided on the 9th of September; on the 14th inst. a scum upon the unfiltered, but none upon the filtered urine; and on the 17th inst. the scum was upon both, but much less thick upon the filtered portion.

4th Sample:—Urine voided on the 9th of September; on the 17th inst. no scum upon the filtered, but a slight one upon the unfiltered urine.

5th Sample:—Urine passed on the 10th of September; on the 17th inst. no scum on the filtered, but a very decided one upon the unfiltered.

6th Sample:—Urine voided on the 14th of September; on the 20th inst. a very decided scum upon the unfiltered, but none upon the filtered urine; on the 22d inst. still no scum upon the filtered portion.

It is thus evident that the removal of even a portion of the animal matter contained in urine, exercises a very marked influence over the development of the fungus, and there is no doubt that if it were more completely separated the results would be still more obvious.

The separation of the whole of the nitrogenised matters almost invariably present in urine, can seldom be effected by filtration; nor do I know of any unobjectionable means by which, without altering the chemical condition of the fluid, it may be removed; were it in any case completely abstracted, it is certain that no development of the fungus would take place.

The condition, then, of the development of the fungus is likewise, to some extent, an indication of the amount of animal matter, especially albumen, contained in the urine; if the fungus be in patches only, then it is certain that the quantity of nitrogenous matter is but small, but if the fungus form a continuous stratum over the whole surface, then it may be inferred that the amount is considerable, sufficient indeed to excite a *suspicion* of the presence of albumen.

The necessity for the presence of animal matter is shown by the fact, that when a little albumen is added to any slightly acidulated solution, the same fungus as that ordinarily met with in the urine makes its appearance in the course of a few hours; without such addition the solution might be kept for any length of time, and no development of the fungus would occur.

A second condition necessary to the growth of this fungus is therefore the presence of animal matter.

But there are still probably other conditions requisite. The abundant growth of this fungus in bottles nearly filled with urine and corked, would appear, at first sight, to show that atmospheric air was not necessary, and from this fact it certainly appears that a very free or large supply of air is not required.

That some portion of air is, however, indispensable, is shown by the following circumstances:—1st. If the bottle containing the urine be well corked, and filled within a very short distance of the neck, the development of the fungus will be retarded, and sometimes altogether prevented. 2d. Occasionally it has happened to me to notice that, after the removal of the cork for a minute only and the admission of air, the plant, which had previously been in a stationary condition, has grown surprisingly. 3d. The fungus will not grow in an atmosphere of carbonic acid, an experiment which may be easily tried by means of a bell jar filled with urine, inverted, and into which a small quantity of carbonic acid has been passed.

A third condition, then, is the presence of a certain amount of atmospheric air, or, rather, of the oxygen of which the air is in part constituted.

We have next to inquire, is the fungus so frequently found in urine a new species, or is it identical with one already known and described? From a careful comparison of this plant, in the several stages of its growth, with the well known *Penicilium glaucum*, it becomes evident that the fungus common to the urine is that species. *Penicilium glaucum* is a very common fungus, and is that which imparts the mildewed appearance so frequently presented by a variety of decaying vegetable and animal substances.

It is now proper to mention, that some of the particulars above referred to in the account given of the conditions necessary to the development of penicilium glaucum, are not altogether new.

That an acid fluid and albumen were conditions essential to the growth of this fungus was first made known by Dutrochet,[1] who recognised the plant, however, only in its filamentous state. These conditions have subsequently been further elucidated by MM. Andral and Gavarret,[2] who also have given a much more complete account of the development of penicilium glaucum, than existed up to the

[1] Mémoire pour servir à l'Histoire Anatomique et Physiologique des Végéteaux et des Animaux, t. ii.

[2] Recherches sur le développement de Penicilium glaucum sous l'Influence de l'Acidification dans les liquides Albumineux Normaux et Pathologiques, 'Annales de Chimie,' t. lxxxiii, p. 385.

time of the publication of their memoir. These well-known observers were likewise the first to show that the presence of atmospheric air, or rather oxygen, was necessary to its growth; this they did by replacing the air over the surface of the fluid with carbonic acid; the development of the plant was entirely arrested for ten days, when the air being readmitted or oxygen supplied, the growth proceeded as before.

The fluids experimented upon by MM. Andral and Gavarret, were the serum of the blood, white of egg, the serosity from the peritonæum, from a hydrocele, and from blisters, also pus; the urine, the most important and interesting in a pathological point of view of all the animal fluids, being so entirely overlooked as not once to be alluded to even in the whole course of their investigations; lastly, one of the conditions laid down by these observers as essential to the development of penicilium glaucum, is really not so, since the fungus makes its appearance and grows in acid solutions containing animal matter which is not albuminous; as, for example, the aqueous humour of the eye diffused through water, a substance which is not coagulable by heat.

From a review, then, of the whole of the facts and observations above recorded, the following conclusions may be deduced:

1st.—That there is very frequently developed in urine a species of fungus known by the name of penicilium glaucum.

2d.—That this fungus ordinarily passes through three stages of development, any one of which is characteristic of the species; it exists first as sporules, these pass into thallus, and from this proceeds the perfect or aërial fructification.

3d.—That the conditions necessary for the development of this plant are, animal matter, especially but not exclusively albumen, an acid solution and oxygen, its growth being likewise much influenced by temperature.

4th.—That it may be developed at will in a variety of

other animal solutions besides the urine in which the above conditions are fulfilled, as in solution of white of egg, acidified with acetic, phosphoric, or any other acid.

5th.—That one of these conditions, viz. the presence of albumen, exists in almost all urines, whether neutral, alkaline, or acid.

6th.—That inasmuch as one of the requisite conditions is wanting in neutral and alkaline urines, the fungus never makes its appearance in these, no matter how much albumen they contain.

7th.—That the plant may, however, be developed at will, in even neutral and alkaline urines, simply by rendering such urines acid by means of phosphoric or any other acid.

8th.—That its presence may be regarded as, to some extent, an indication of the degree of acidity of the urine.

9th.—That it is not characteristic, as has been supposed, of the presence of an abnormal quantity of albumen in acid urines, since it is frequently developed in many urines which contain only a normal amount of epithelium and mucus, and in which also not a trace of albumen can be detected by means of heat and nitric acid.

10th.—That, nevertheless, it affords some indication of the amount of animal matter contained in acid urines; for where this is large, the fungus is usually developed in considerable quantity, and in all such cases it is proper that the urine should be tested for albumen.

11th.—That this fungus is no indication whatever of the presence of sugar in the urine, since the observations above recorded were all made upon non-saccharine urines, and since the fungus may be developed at will in solutions which it is certain do not contain a particle of sugar.

I have now to remark, in bringing the *first part* of this communication to a conclusion, that the observations detailed on the development of penicilium glaucum in the urine under different conditions, were made principally in the summer and autumn of the year 1849.

Part II.

I come in the next place to the consideration of the second division of the subject—viz. the development and growth of Torulæ in saccharine urine.

From the quotations given in the first part of this communication, it appears that, up to the present time, great difference of opinion prevails as to the value of the torula-test as an indication of sugar in the urine—some asserting that it affords positive evidence; others denying altogether that it is a reliable test. From the facts and observations already advanced, it is at least certain that torulæ in urine are not, in all cases, indicative of the presence of sugar. It has yet to be determined, however, whether the torulæ contained in saccharine urine are not characterised by such peculiarities as constitute a satisfactory test for sugar when present in that excretion.

For the determination of this point, a number of samples of diabetic urine were placed in distinct vessels, the changes which ensued being observed from day to day. Each sample was divided into two, and sometimes three, portions.

The first was placed in a glass, and freely exposed to the air; the second, in a bottle, air being admitted to a limited extent only through an aperture in the cork; and the third was enclosed in a tightly-corked bottle.

The following changes were observed by the eye alone to occur in that portion of the urine which was exposed to the air:—

In the course usually of two or three hours after being voided, the urine began to lose its transparency, and to present a milky appearance.

At the end of from 24 to 36 hours, cloudy, gelatinous-looking masses appeared suspended in the urine just beneath the surface, but extending some depth into the fluid. Although visible on the surface, the form and size of the masses were best seen from a side view. These masses, being exceedingly soft and delicate, quickly broke into

pieces on the least disturbance of the glass, and slowly subsided to the bottom; the same thing happened occasionally when the masses had attained considerable size—an inch or more in diameter—even when the urine remained undisturbed. Thus, after a few hours, the exact time varying according to temperature, there was an accumulation of these gelatinous-looking masses, not only on the surface of the urine, but also at the bottom of the glass, forming a cloudy sediment, the turbidity of the whole urine now having become very considerable.

Entangled in the masses, particularly those near the surface, were numerous bubbles of gas; these, separating from time to time, escaped into the air. Many bubbles were also thrown off from the masses at the bottom of the vessel, rising slowly to the surface; occasionally a number of globules became developed in these masses, which ascending, carried with them the masses in which they were included.

This elimination of gas was continued for some days, and was so great as clearly to indicate an active fermentation in the fluid. The gas generated was ascertained, by the following simple proceeding, to be carbonic acid gas:

Two or three ounces of the urine were placed in a wide-mouthed glass jar. In this a second vessel filled with lime-water was suspended, the mouth of the jar being well secured. The lime-water was soon observed to become turbid, and at the end of two days a considerable deposition of a white powder had taken place in the inner vessel. This precipitate effervesced on the addition of acetic acid, showing that the gas which had escaped from the urine and combined with the lime was the carbonic acid gas. A modification of this experiment was performed by means of a *Woolfe's* apparatus.

One of the flasks was partly filled with the urine; the other, with lime-water. A bent glass tube adapted connected the two, one end dipping into the lime-water. The gas, as it was evolved from the urine, passed through the tube, rendering the lime-water turbid, and producing a precipitate, which effervesced as before on the addition of an acid.

For the next two or three days, reckoning from the end of the first 36 hours, the urine continued to present nearly the same character, except that the masses increased in size and number, became whiter, and acquired greater consistency; the globules of gas eliminated also becoming larger and more numerous.

At the end of about the fifth or sixth day the gelatinous masses had disappeared, some having subsided to the bottom, while others had gradually merged into and formed a continuous stratum of a fawn colour, having, to a certain extent, the consistence and characters of beer-yeast.

This stratum, from day to day, acquired increased firmness; so that, at the end, usually of seven or eight days,—sometimes earlier,—it might be removed as a distinct and coherent layer. By degrees its texture became altered, and it soon presented a woolly and filamentous appearance. Lastly, a crop of delicate transparent threads sprang up from the surface, bearing on their summits minute spherical heads of a black colour, barely visible with the naked eye.

In the course of a few days, the stratum, now of considerable thickness, gradually altered in colour—became brownish—and, after a further time, soft and brittle, ultimately breaking up and sinking to the bottom of the glass.

These changes, visible with the eye alone, are so marked and peculiar, that when once carefully noted, they cannot be mistaken. But there are still other more important changes and peculiarities corresponding with the several outward changes above described, and for the determination of which the microscope is necessary.

Examined with that instrument, the cloud-like masses were found to consist of the minute sporules of a fungus, imbedded in a mucoid base. These sporules were very irregular in size; some, when viewed with an object-glass of $\frac{1}{8}$th of an inch focus, being visible as mere black points, while the largest did not exceed the $\frac{1}{6750}$th of an inch in

diameter. These masses, composed of the minute sporules, constitute *the first sub-stage* of the development of the fungus. (Pl. II, figs. 1, 2.)

The soft, fawn-coloured scum is composed, for the most part, of circular sporules many times larger than the former. These, although usually separate, are occasionally feebly united in rows formed of two, three, or even more sporules; sometimes the sporules collect together in groups, the smaller surrounding the larger, or parent-cells. Intermixed with the sporules are also a few jointed and beaded threads.

These sporules, like the former, vary considerably in size, the smallest being scarcely the $\frac{1}{1600}$th of an inch, whilst the largest are as much as the $\frac{1}{555}$th of an inch in diameter, the medium size being the $\frac{1}{952}$d of an inch. (Pl. II, figs. 3, 4. Pl. III, fig. 1.)

Between these sporules and those first described, it will be observed a considerable difference of size exists; this, for a time I was at a loss to explain; the explanation is furnished, however, by a consideration of the manner in which the sporules are developed.

The sporules are multiplied by the constant escape, from the interior of the larger sporules, of other and smaller cells, these, on their escape, appear on the surface as buds, and are usually included in a pouch-like protrusion of the parent-cell wall, which with its contained nucleus, is finally thrown off, becoming a new and independent sporule.

This evolution of sporules at the early period of the development of the fungus, is so rapid and continuous as not to allow any of the sporules to attain a large size. Subsequently, however, as the quantity of sugar becomes diminished, the evolution is less rapid, and time is afforded for a large proportion of the sporules to acquire the size characteristic of the fungus in *the second sub-stage* of its development.

The more consistent stratum is made up of branched and jointed threads, intermixed with a few separate circular sporules. These threads are frequently beaded, the beaded cells being sometimes placed in the course, but more frequently forming the termination of the threads. In the latter case, the beaded extremities are often raised above the surface of the urine, and project a short way into the atmosphere. (Pl. v, fig. 1. Pl. III, fig. 2.)

Not unfrequently single cells several times larger than the others are observed; these are placed in the course of the beaded portion of the threads; but sometimes they are seen lying loose; these cells appear to be of the nature of vesicles. (Pl. III, fig. 3.) This forms the second stage of the development of the fungus, that of thallus.

The stratum presenting a woolly structure is divisible into two parts; the one, rests upon and is immersed in the urine; the other, projecting into the air, may be termed aërial. The first consists principally of the thallus above described, while the second is made up of the slender, transparent, jointless, and occasionally branched stems which here bear the globular heads.

The state and appearance of the heads vary with the development. At first they present a smooth outline from being covered with a delicate membrane. (Pl. v, fig. 2.) This afterwards bursting and becoming retracted, a rounded mass of circular sporules of a brownish colour is disclosed to view. The sporules falling off, leave the dilated extremities of the threads or filaments exposed.

These changes constitute the third or perfect stage of development of the fungus, that of aërial fructification.

The rapidity with which the fungus is developed is dependent, to a great extent, on temperature; heat, as the warmth of summer, greatly accelerates, while cold retards the growth to an equal degree. So much is this the case, that it is doubtful whether the sugar fungus would be developed at all in mid-winter, and when the thermometer was below the freezing point.

The observations upon the development of the diabetic fungus, above recorded, were made during the summer months; the periods given are those which were found to correspond to the several stages of the growth of the fungus at

that season of the year. It must be remembered, however, that the development is influenced considerably by variations of temperature, even in summer.

Although the appearances above described were all noticed in the first sample of saccharine urine subjected to observation, yet a variety of other samples, which were afterwards submitted to similar investigation, furnished results in all essential respects identical.

Such is a brief description of the changes which ensued in samples of saccharine urine exposed to the atmosphere. We have, in the next place, to notice those changes which occurred in the two other portions of the first urine, to one of which air was admitted to a limited extent, and from the other entirely excluded.

The portion of urine partially excluded from contact with the air quickly became, like the first, whitish and opaque; the cloud-like masses appeared as before, broke up on the slightest motion, and subsiding, formed a copious sediment. Many globules of carbonic acid gas arose from all parts of the liquid, and after accumulating on the surface escaped into the atmosphere. The masses were, however, fewer and smaller than in the sample freely exposed to the air, and the globules of gas were much less numerous, and their evolution ceased at an earlier period.

Examined with the microscope, the masses were ascertained to consist, as in the first portion, of myriads of minute sporules.

With the formation of the masses, the development of the fungus ceased; the only ulterior changes being, that the masses gradually became whiter, and more consistent.

The sporules, no matter how long the urine was kept, never attained the large size which distinguishes them in a more advanced condition of development.

The urine contained in the closed vessel was turbid when introduced; this turbidity afterwards increased somewhat, and bubbles of carbonic acid gas became evolved here and there. At the end of a few hours, however, the weather being extremely warm, the bottle burst with a loud explosion, breaking into many pieces, which were scattered far and near; the liberated urine effervescing on its escape, as though it were so much ginger beer. The same occurred in a second sample; but in other trials, this result was obviated by employing a Woolfe's apparatus. One of the flasks was partly filled with lime water, which, by absorbing the gas as quickly as generated, removed the pressure, and so prevented the bursting.

The changes which took place could now be readily noted: the urine, slightly turbid at first, soon became more opaque, and some carbonic acid gas was evolved, yet its opacity was soon lost; the elimination of gas ceased, and ultimately it became perfectly transparent. The few minute sporules which were originally diffused throughout the liquid fell to the bottom, forming a slight sediment, and for whatever period the urine was kept, no gelatinous masses were developed in it, nor was any stratum of fungus formed.

From the great differences observed in the fungus in the several portions of urine, it is very evident that free exposure to the air is a condition indispensable to its perfect development; deprived of this, its growth is quickly arrested.

It is also very evident from the description and illustrations now given, that the fungus developed in saccharine urine is a species very different from that treated of, in the first part of this communication, viz., *Penicilium glaucum*.

Further, a comparison of the diabetic fungus with the yeast plant, shows that the two are identical; a point of very considerable interest. The figures which accompany this communication contrasted with those of the yeast plant, published in the 'Lancet,' vol. i, 1850, are in themselves sufficient to establish this identity.

Up to a very recent period, great uncertainty, and even mystery, hung over the development of the yeast plant; the efforts made by able observers, to trace it through all the phases of its development, having for the most part completely failed.

In the communication referred to,[1] I gave a description of the yeast plant; and traced it through several stages of development; I followed the transformation of the sporules into branched threads, or thallus; detected the beaded threads and the large sporangia-like cells; and at that time thought I had really traced it, step by step, to its final condition. I have since ascertained, however, that under favorable circumstances, perfect aërial fructification is produced, precisely similar to that described as constituting the last and perfect stage in the growth of the diabetic fungus.

Now the changes described, as occurring in the three portions of the same sample of diabetic urine placed under such opposite circumstances, were with slight differences repeated in a variety of other samples, some obtained from patients labouring under diabetes in different degrees. So there is no doubt, but that these changes, under similar conditions, are constant, and therefore they afford valuable and unmistakeable evidences of the presence of sugar in the urine.

It is not to be understood, that the whole of the changes described as occurring in diabetic urine, were fully appreciated from the observation of a single specimen, and that the first submitted to examination. It was necessary in order to arrive at all the results above recorded, to watch the changes which ensued in a variety of samples; but these changes having once been clearly ascertained, the whole of them were readily afterwards followed out in even single specimens.

I will now proceed to give the results, recorded from day to day, derived from the observation, as well as chemical and microscopical examination, of several samples of diabetic urine, in order that the precise and positive character of the facts upon which the description contained in the foregoing pages is founded, may be the more clearly comprehended.

[1] Bread and its Adulterations, 'Lancet,' April, 1850.

Results recorded from day to day, of the Examination of Samples of Diabetic Urine.

1st Sample:—This urine was passed on the morning of the *7th* of *June*, 1852, but did not come into my possession until the 11th inst., it having been kept in a corked phial; it was very acid, had a specific gravity of 1037, and examined with the microscope there were detected in it numerous octohedra of oxalate of lime; it was divided into two portions.

1st portion in open vessel.—Examined on the 11th inst. There were observed near the surface of the urine a few cloud-like gelatinous masses composed of myriads of minute sporules imbedded in a mucoid base. Sporules of *Penicilium glaucum*, some round, but the majority of an oval form, were likewise noticed resting on the urine.

Examined on the 13th inst. There were seen on the surface with the naked eye a few small circular patches of Penicilium glaucum, composed of sporules, some round, but the greater number oval, while at the bottom of the glass was an abundance of sporules, both small and large, of the saccharine torulæ, as well as a few filaments of the same, some with bearded cells.

Examined on the 19th inst. The Penicilium was still in the same state, but a thick white woolly stratum of the diabetic fungus had become developed, forming a ring round the whole margin of the glass; this consisted principally of the thallus; that is, of the root-like portion of the plant, which is made up of branched and bearded threads; intermixed with the filaments were, however, numerous large sporules, and from the upper surface of the stratum a considerable number of straight filaments shot up.

Examined *June 23d.* The woolly stratum now extends nearly over the whole surface of the urine; and the vertical threads are seen by the eye alone to bear on their summits the minute spherical and black heads which are characteristic of the fungus in its perfect state. (See Pl. v, fig. 2.)

Examined *July 3d.* The globular heads have lost the smooth outline which they at first presented, and they now consist of masses of sporules of a rounded form and deep brown colour, supported on the extremities of the vertical filaments; in some cases, the sporules have fallen off, the dilated extremities of the filaments then coming into view. The stratum breaks up readily; and on replacing it in the glass from which it had been removed for a few minutes, it sank to the bottom.

Examined *July 19th.* Stratum risen again, and spread over the whole surface of the glass; patches of Penicilium glaucum in perfect fructification have appeared; the diabetic torula now seen is chiefly the results of a second development, which, like the first, has passed through all the stages, even the last, that of aërial fructification.

The urine is now pale, but thick and turbid, as though mixed with flour; and there is a copious deposit, consisting principally of the sporules of the diabetic fungus: it is alkaline, contains an abundance of triple phosphate, and the potash and copper tests furnish no results, showing that the sugar has at length disappeared.

2d portion in closed vessel.—Although passed on the *7th* of *June*, this portion was not placed in the closed vessel until the 11th inst., the saccharine torula had therefore become developed to some extent previous to the exclusion of the atmosphere.

Examined on the *13th* of *June*. Urine in the same condition, and containing the same structures as were detected in the portion exposed to the air at the same period, the only difference being that there was very much less of the saccharine torula.

Examined *19th June*. No increase in the quantity of saccharine torula, and none present at the top of the urine, the pellicle of Penicilium on surface in the state of oval sporules.

Examined *3d July*. Saccharine torula in the same state, no scum of Penicilium on surface.

Examined *18th July*. Urine pale, perfectly clear, and possessing a strong acid reaction; still contains traces of sugar.

Examined *16th September*. Urine bright, clear, and still very acid; the sugar has now disappeared entirely.

2d SAMPLE:—*Placed in partially closed vessel.* Passed *22d May*, but did not come into my possession until some time afterwards, it having been kept in a corked phial. When examined with the microscope, there were detected in it at the bottom a few sporules, both large and small, of the saccharine fungus, hexagonal crystals of uric acid, and octohedra of oxalate of lime, (see Pl. III, fig. 3.) It was placed in a partially closed vessel on the *14th June*.

Examined *19th June*. There was an abundant gelatinous frothy scum on surface, consisting of the small sporules of the diabetic torula, and of numerous bubbles of carbonic acid: there was also a considerable deposit of the small sporules, intermixed with a few of the large ones at the bottom of the vessel.

Examined *3d July*. Gelatinous and frothy scum nearly all subsided to the bottom, the sediment consisting, as before, of the minute sporules, with a few large ones; urine still acid.

Examined *18th July*. The thick frothy gelatinous scum had reappeared on the surface, but on shaking the urine it again fell; there is now a very considerable deposit divisible into two layers, the lower of a fawn colour, consisting of the small and large sporules of the saccharine torula, and the upper of the small sporules only: the smell of the urine is sour and acetous, but the reaction slightly alkaline; sugar gone entirely.

Examined *8th August*. The crystals of uric acid have disappeared, and their place is supplied by numerous globules of some urate: small sporules of the diabetic fungus may still be detected. It will be observed that neither in this nor the previous specimen did the saccharine torula attain its full development.

3d SAMPLE:—*In open vessel.* This urine did not reach me until some time after it had been passed; it was when received, however, of highly specific gravity, acid, and contained a considerable quantity of sugar. Exposed to the air for some days, the surface became covered with the thick woolly stratum, which, on examination, was found to consist of the diabetic torula in its perfect condition.

4th SAMPLE:—*1st portion in open vessel.* Urine passed *23d July*, 1852; specific gravity 1033, acid.

Examined *July 24th*. Copious gelatinous-looking flocculi, with many bubbles of carbonic acid imbedded in and surrounding them, have appeared near the surface of the urine; these consist of vast numbers of minute circular and oval sporules, immersed in a mucus-like base. The urine has a milky or floury appearance, which is occasioned by the great numbers of sporules diffused throughout.

Examined *25th July*. Flocculi increased in size, and many have fallen to the bottom, bubbles of carbonic acid gas are seen rising from all parts of the urine to the surface.

Examined on the *27th July*. Nearly in the same state.

Examined *30th July*. Surface covered, particularly at the edges, with a thin plicated scum of Penicilium, which consists of oval sporules, some extending into short threads. No large sporules of the saccharine torula have as yet appeared; the urine is still very acid, and has a specific gravity of 1024.

Examined *8th August*. The plicated thin scum, consisting of the sporules and threads of Penicilium, is still seen at the sides; and in the centre a large mass raised above the surface, and also extending much beneath it, having the consistence and colour of yeast: this mass consists principally of the large sporules of the saccharine torula, and which are not distinguishable under the microscope from those which form the yeast plant; the urine is thick, as though flour were diffused through it, very acid, and still contains sugar, but a small quantity, judging from the action of the potash test.

Examined *8th August*. The perfect fructification of the

Penicilium has now become developed, forming a green circle round the yeast mass. The further changes which ensued in this sample were not followed.

2d portion in partially closed vessel.—Examined on the *24th July*. This urine is in the same condition as the specimen in the open vessel at the same date.

Examined *25th July*. Same state as the previous specimen.

Examined *8th August*. A thin pellicle of Penicilium on surface, consisting of sporules intermixed with a few short threads; gelatinous masses both on the surface and at the bottom of the vessel, a very few diabetic sporules of large size being detected in the latter situation: specific gravity 1022, very acid, and contains more sugar than the urine exposed to the air.

Examined *17th September*. The masses near the surface have become whiter and more consistent, and there is a very considerable deposit of the same. With the microscope the masses were found to consist of the sporules of the saccharine fungus, both large and small, but chiefly the latter, mixed with a few broken filaments: resting on the flocculi near the surface were many fine crystals of oxalic acid. This urine has a smell like that of sour milk, is very acid, and still contains a little sugar.

3d portion placed in closed vessel.—Urine a little thick and white, as though mixed with flour; bubbles of gas rising from all parts to the surface, showing that it is on the work: bottle burst the same day with a loud explosion, the fragments being scattered here and there, and the urine effervescing like so much ginger beer.

5th Sample:—*1st portion placed in open vessel.* Passed *2d August*: the urine became milky almost as soon as voided, from suspended sporules of the saccharine torula; it also quickly threw up a large quantity of carbonic acid gas.

Examined *8th August*. Scum of torula on surface composed, in part, of the oval sporules and branched threads or thallus of Penicilium glaucum, and in part of the small sporules of the saccharine fungus: at the bottom of the vessel there was a considerable deposit formed by the small diabetic sporules only. At this date the urine was very acid, and still contained sugar, although it only had a specific gravity of 1006: the density of the urine when first passed was not ascertained; it was most probably of low specific gravity, however.

Examined *14th August*. Diabetic torula in nearly the same condition; sugar all disappeared. The fungus in this instance did not pass through all the stages of its development, in consequence of the early and rapid transformation and disappearance of the sugar.

2d portion in partially closed vessel.—Examined *August 8th*. Very acid, specific gravity 1004: thin scum of torula on surface formed of the sporules of the saccharine fungus and of Penicilium glaucum intermixed; a considerable deposit of the same.

Examined *17th August*. Saccharine fungus in the same state; urine smells very sour, and is strongly acid.

Examined *17th September*. A thin brownish scum of torula on surface, composed chiefly of the small sporules of the saccharine fungus: urine gelatinous-looking, very acid, and of a sour smell; does not now contain sugar.

3d portion in closed vessel.—The urine was placed in the closed vessel the day on which it was voided; the next morning it was milky, and many bubbles of gas had collected on the surface: in the course of the day the vessel burst with a loud noise, the urine effervescing briskly from the large quantity of carbonic acid gas set free.

6th Sample:—*1st portion placed in open vessel.* Urine passed *7th August*, of specific gravity 1028, became somewhat milky shortly after being voided.

Examined *8th August*. Several gelatinous-looking masses had formed on the surface, where also large numbers of bubbles of carbonic acid gas had collected; the subsequent changes were the same as in the other samples freely exposed to the air; the fungus continued to grow until it reached its complete development.

The changes which occurred in the other two portions of the same urine, the one partially exposed to the air, the other excluded from it, were so nearly similar, that it is unnecessary to describe them. Sufficient details have now been given to show the precise character of the alterations which ensue in specimens of saccharine urine placed under different conditions.

But it may be said that there are already tests sufficient of the presence of sugar in the urine; and, therefore, although the torula-test is very satisfactory, yet that it is not needed. To this objection I next reply—

There is no doubt but that in cases of confirmed diabetes, where the quantity of sugar in the urine is very considerable, the potash and copper tests afford positive indications; but do they in slight and incipient cases of that disorder?

The physician is not unfrequently consulted in supposed cases of diabetes, the symptoms being—loss of health, emaciation, but particularly an elimination of an increased quantity of urine; and yet, failing when he comes to test the urines by the ordinary reagents to discover the presence of sugar, he generally pronounces these cases not to be diabetic. Does he, in this way, always arrive at a correct conclusion?

The detection of diabetes in an early stage, where sugar is present in the urine, either occasionally only, or in small quantities, is of the highest importance; for it is then chiefly that the physician may entertain the hope of treating the disorder successfully.

In an article published in the 'Lancet,'[1] I showed that diabetic sugar might be introduced in quantities by no means inconsiderable into many different urines, and yet not be discovered afterwards by the most skilful application of the ordinary tests.

Now, this fact confirms in a remarkable manner the suspicion entertained by many that urines may contain small quantities of sugar, and yet that this shall not be detected by any of the methods ordinarily in use.

[1] On the Tests for Sugar in the Urine, 'Lancet,' 1851.

I have now ascertained that this is not unfrequently the case.

Several specimens of urine voided in a supposed case of incipient diabetes were set aside for observation, they having previously been carefully tested for sugar, but none having been discovered.

In some of these specimens, somewhat to my surprise, although such a result was not of course wholly unanticipated, the gelatinous masses previously described appeared, bubbles of carbonic acid were eliminated, and the diabetic torula or fungus was traced through all the stages of its development—even the last, that of perfect aërial fructification.

The only differences observed in the development of the fungus in these specimens contrasted with its growth in samples of urine containing large quantities of sugar, were in the size and number of the masses, which were fewer and smaller, in the thinness of the yeast-like stratum formed, and in the circumstance that this, as well as the perfect fructification which sprang from it, did not cover the whole surface of the liquid, but extended over part only, forming one or more patches.

In other specimens development entirely ceased at the end of the first stage, the urine became turbid, the gelatinous masses were formed, and carbonic acid evolved; but here the growth stopped—the masses broke up, and after a time disappeared.

Lastly, in other specimens, the diabetic torula did not make its appearance at all.

It was particularly noticed that those specimens in which the fungus went through all the stages of development were more than usually acid.

That those urines in which the development ceased quickly were but feebly acid when passed, the acidity soon being entirely lost.

Finally, that the urines in which the fungus did not make its appearance at all were frequently either alkaline when voided or very quickly became so.

It appears, then, that in the diabetic fungus we have a most valuable, and, indeed, the only certain and available, test of the presence of sugar in urine in small, but not inconsiderable quantities.

It has been remarked that it was only in the more acid samples that the fungus became fully developed. This may be readily accounted for.

When describing Penicilium glaucum, I stated that the conditions necessary for its development were free exposure to the atmosphere, albumen to act as a ferment, and an acid liquid. Now, the same conditions are requisite for the growth of the diabetic fungus, with the addition of a fourth —the presence of grape or diabetic sugar.

In the feebly acid or alkaline urines one of these conditions is not fulfilled, and, therefore, the fungus is not developed.

It may be said, however, that urines which contain sugar are always acid, and therefore, that the fungus should be developed in all cases where this is present. Where the quantity of sugar is very considerable the urine no doubt is constantly acid; but whether it is always so, where the amount is small, is less certain. With a view to determine this point, I adopted the following proceeding:

Several samples of the feebly acid or alkaline urine passed by the patient the subject of incipient diabetes were obtained; to these was added sufficient phosphoric or acetic acid to impart the decided acidity necessary for the development of the fungus should sugar be present. The specimens were watched from day to day, and as any lost their acidity, as sometimes happened, further quantities of acid were added. This proceeding furnished the following results:—In the whole of the samples the circular patches of Penicilium glaucum quickly made their appearance, ultimately passing through all the stages of their development. In one of the samples only was there any formation of the sugar fungus, and in this the growth did not proceed beyond the stage of large circular sporules. One would, therefore, be disposed to conclude as the result of this

experiment that sugar is not ordinarily contained in slightly acid, neutral, or alkaline urines.

In suspected cases of diabetes, then, should the fungus not appear in the first specimens of urine examined, it must not be concluded that sugar is not present, even although the urines possess some degree of acidity. We must ascertain whether they are sufficiently acid, and, if necessary, must increase that acidity; neither must we decide against the presence of sugar in those instances in which some of the samples of urine examined are alkaline, for, as is also shown above, sugar may be present in some and absent in other specimens. In the case of incipient diabetes, which I have made the subject of special observation, I have particularly noticed that sugar is most liable to occur in the urine voided after error and excess in diet.

In this place the observations of Dr. Basham, 'On the Cholera Sporules,'[1] may be referred to. While searching the urine of a dyspeptic patient for crystals of oxalate of lime "the appearance of some annular-formed cells attracted attention, some with minute nuclei. The field of the microscope presented these sporules amongst many crystals of the oxalate and some epithelium and mucous globules." Again, in examining, in another case, some urine which was strongly acid, abounded in stellated crystals of uric acid, and was of specific gravity 1018, Dr. Basham observed some sporules which he thus describes: "They are somewhat like the torula of diabetic urine; but they want the true confervoid character. They are oval cells, arranged by their long diameter in a bead-like form, with minute granules or cellules developing themselves from the surface and junction of the parent-cells."

Dr. Basham made pen-and-ink sketches of the appearances observed at the time. These are published in the third edition of Dr. Golding Bird's work, and from an examination of fig. 58, which represents the character of the fungus detected in the second sample of urine examined, I entertain no doubt whatever but that this drawing

[1] Medical Gazette, 1849, vol. xliv, p. 686.

exhibits a condition of the sugar fungus. The urine, therefore, although not of high specific gravity, contained a small quantity of sugar, to which the presence of the torula was doubtless due. This case affords further evidence of the value of the torula-test for sugar in the urine.

From the facts which I am now about to adduce, it becomes extremely probable that sugar frequently makes its appearance in the urine in connection with a more or less alkaline condition of that fluid. It is at all events certain that it sometimes does so.

For some years before, and up to the period of the discovery of sugar, the urine in the case of diabetes, so often referred to, was when first passed occasionally alkaline or neutral, but most frequently feebly acid. On becoming cold, and even while still acid, it usually threw up an abundant iridescent pellicle of phosphate of magnesia; and when cold, it deposited large quantities of triple phosphate. One of the consequences of this want of acidity was that Penicilium glaucum, one of the best tests of acidity, but seldom became developed in it, and, when it did appear, it still more rarely passed through all the stages of its growth.

But the most remarkable character of this urine was, and still is, that it frequently contains very large quantities of phosphate of lime in a crystallized state. Now, this earthy salt occurs but very rarely in the urine in this condition, and of it, so far as I am aware, no accurate or detailed description has yet been given. I have myself met with crystals of phosphate of lime in several different cases; and in 1850 I published in the 'Lancet' a short notice of the form and composition of certain modifications of the crystals of this phosphate.[1]

Although this salt has not yet been fully described, we yet find in works on organic chemistry one or two brief references relating to it.

Thus, in vol. ii, p. 133, of Simon's 'Animal Chemistry,'[2]

[1] On certain Important Points in the Chemistry and Pathology of the Urine, 'Lancet,' January 19, 1850.
[2] Translation by Dr. Day.

the following observation occurs: "The phosphate of lime may be recognised under the microscope as an amorphous mass. Sometimes, but rarely, it occurs in a crystalline form. Both varieties are figured in fig. 26." In this figure a granular powder, as well as certain foliaceous masses, are represented. The form of these is so irregular that it is impossible to refer them, with anything like certainty, to the crystals I am about to describe; while, appended to the explanation of the figure, a remark is added to this effect — the foliaceous bodies are most probably urates. It thus appears that Simon was himself in some doubt respecting the composition of the irregular bodies which fell under his observation.

Again, Dr. Griffith, in his little work, copies Simon's figure, and adds, "I have specimens of this."[1]

Lastly, I find crystals of phosphate of lime described and figured under the name of "*Penniform Crystals of the Neutral Salt,*" by Dr. Golding Bird. The description is as follows: "This very elegant variety of the neutral magnesian phosphate has only lately fallen under my notice, and has occurred in a very few cases. It presents the appearance of striated feather-like crystals, two being generally connected, so as to cause them to resemble a pair of wings. (Fig. 35.) I cannot give any satisfactory explanation of the causes of this curious and elegant variety, or whether they differ in any way chemically from the prismatic form. The few specimens I have met with occurred in acid urine."[2]

I found my opinion that the crystals thus described by Dr. Bird are not composed of the neutral triple phosphate, but of phosphate of lime, upon an examination of one of Dr. Bird's original preparations, kindly lent me, along with others, for the purpose of having figures made from them.

Since the occurrence of these crystals is of much importance, in more respects than one, but particularly in relation to the presence of sugar in the urine, I will describe the forms which they assume, and especially the

[1] Practical Manual. [2] Urinary Deposits, 2d ed., p. 212.

method of analysis adopted, so that no room may be left for supposing that a correct conclusion with respect to the composition of these crystals has not been arrived at.

First, I would observe the crystals have presented themselves to my notice in the urine for at least the last three or four years. Although generally present, especially when the health is more than usually affected, yet they are sometimes absent entirely,—it may be for days together,—or they may be absent from one specimen and present in the next. They vary also in number: sometimes there are but few; usually they occur in great abundance, particularly in the more acid samples, in which they are formed even while the urine retains a decided acid reaction, and long before the formation and deposition of the crystals of triple phosphate.

Viewed with a half or quarter inch object-glass, the crystals appear wedge-shaped—being broad at one extremity and narrow at the other; but when the $\frac{1}{8}$th inch glass is brought to bear upon the broad end of the crystal, which is the only completely-formed part, it is then seen that they are really six-sided prisms, with oblique, and sometimes dihedral, summits. Occasionally, but rarely, both ends of the crystal are perfect, and then the wedge-shaped appearance is lost, and both extremities are alike. Sometimes they occur singly, but the greater number usually form, by the union of several crystals by their narrow extremities, rosettes more or less perfect; in other cases, but this is very seldom, the crystals are compound, each breaking into numerous secondary crystals; when this occurs, both ends are generally of the same shape.

The crystals are formed first, and chiefly on the surface of the urine, but they are sometimes found in large quantities at the bottom of the glass, and even adhering to the sides; those on the surface are frequently imbedded in a crust of iridescent phosphate of lime.

The crystals were twice carefully analysed, being obtained for the purpose, in the following manner: after having been identified by means of the microscope, they were

skimmed off the surface of the urine, and repeatedly washed in distilled water, to free them, as far as possible, from impurity; it is rarely, however, that they can be procured in any quantity, entirely free from admixture with small quantities of either phosphate of magnesia, triple phosphate, or even both these.

In the first sample analysed, there were present a few crystals of triple phosphate, and a little phosphate of magnesia; the deposit thus contaminated exhibited the following characters: it was slowly dissolved by cold acetic acid, and very rapidly by hot; from this solution oxalic acid threw down a copious precipitate of oxalate of lime, when boiled with liquor potassæ ammonia was evolved; it was fusible with difficulty only before the blowpipe.

From the above reactions, it is evident that the crystals are composed principally, if not entirely, of phosphate of lime; the small quantities of magnesia and ammonia detected being derived from the triple phosphate and phosphate of magnesia, which were previously ascertained to be present; it is nevertheless possible, that the lime may be combined with a small quantity of ammonia.

The second sample was almost, if not entirely, free from the ammonio-magnesian phosphate, but it was admixed to a very small extent with phosphate of magnesia, animal matter in the form of vibriones, and perhaps with oxalate of lime.

On boiling a few of the crystals in a test tube with a little liquor potassæ, a small quantity of ammonia was evolved, which communicated a red stain, not permanent, to turmeric paper. After boiling for a quarter of an hour, the liquid was diluted and set aside; in a few hours, the clear supernatant liquid was poured off, then acidulated with acetic acid, and tested with lime for oxalic acid, on standing for two or three hours a faint precipitate of oxalate of lime formed. A little more of the deposit was then boiled with acetic acid, and the clear liquor tested for lime with oxalic acid, when an abundant precipitate was produced. After the precipitation of all the lime, the solution was supersaturated with ammonia, and allowed to stand, when crystals of bibasic phosphate of magnesia and ammonia separated. Finally, heated before the blowpipe, the crystals melted with difficulty.

As the result of this analysis, it again appears that the crystals consist, for the most part, and in all probability entirely, of phosphate of lime. A trace of ammonia only was detected on this occasion, but very perceptible quantities of phosphate of magnesia and oxalate of lime, the former of these, and most probably the latter also, were present as impurities.

The question next arises, is there any connection between the crystals of phosphate of lime and sugar in the urine?

I have described these crystals as occurring most frequently and abundantly in the more acid samples of urine; now it is in precisely these that sugar most commonly makes its appearance.

Again, between sugar and lime there is a great and well-known affinity.

Lastly, lime is apt to occur in saccharine urine in another form, in combination with oxalic acid.

These considerations render it probable that there is some such connection; before, however, we shall be in a position to come to any definite conclusion on this point, further observations are required.

I will now give the results, as recorded from day to day, derived from the examination of specimens of the urine passed in the case of incipient diabetes.

Results of the Examination of Specimens of the Urine voided by the Patient the subject of Incipient Diabetes.

1st Sample:—Urine passed 5th August, slightly acid, having a specific gravity of 1015, clear when voided, and of a pale brandy colour, but becoming cloudy and thick as it cooled; flocculi separated from it, which subsiding formed a deposit three fourths of an inch in depth in a twelve-ounce

bottle; while the urine was being passed a slight smarting sensation was felt.

Examined *6th August.* The urine has now become alkaline, the deposit white and granular.

Examined *8th Aug.* A scum or pellicle has now formed over the whole surface of the urine, this consists of vibriones, a very few crystals of the ammonio-magnesian phosphate, and an immense number of crystals of phosphate of lime, mostly in stellæ, but some also single. The first analysis of the crystals given at p. 65 was made from this sample.

As at the time no suspicion was entertained that the case was one of diabetes, no search was made for the sugar fungus.

2d Sample:—Passed early in the morning, on the *5th of August.* Urine clear, very acid; specific gravity 1024, and of a very deep colour.

Examined *8th August.* Many small circular patches of a variety of Penicilium glaucum in all stages, some composed of sporules, others of thallus, and some fully developed, and of a dark olive-green or brown colour; interspersed amongst these were a few white woolly tufts of Penicilium of larger size.

Examined *27th Aug.* Tufts of Penicilium in much the same state, but faded somewhat, and now imbedded in a pellicle of phosphate of magnesia. While examining one of the tufts under the microscope, many large sporules, as well as some of the threads forming the thallus of the saccharine fungus, were somewhat unexpectedly discovered, and it was afterwards ascertained that a considerable quantity of this fungus in an advanced state of development was present, not only on the surface, forming the tufts in part, but also at the bottom of the vessel.

Examined *5th September.* Urine thick and turbid, alkaline, with much deposit at bottom of glass.

Examined *17th Sept.* Urine dark brown; on examination of the tufts with the microscope, numerous blue masses were seen, but there were no crystals of phosphate of lime; the deposits consisted of vibriones, a great many spherules of some urate, and a few crystals of triple phosphate.

The saccharine fungus in this specimen did not reach its complete development.

3d Sample:—Examined *5th September*. Passed about ten days since, but no record kept of its characters at that time. A thick yellow scum has spread all over the surface, with here and there imbedded in it a patch of fawn-coloured penicilium in perfect fructification, one patch somewhat green in the centre; this scum is composed of vibriones, phosphate of magnesia, and an immense number of the crystals of phosphate of lime, some separate, others in stellæ; the urine is still slightly acid, thick, and of specific gravity 1015.

Examined *17th Sept.* Urine alkaline; the scum first formed was removed, and the crystals of phosphate of lime after being well washed were submitted to analysis; a second scum similar in appearance has now collected on the surface, this is composed entirely of phosphate of magnesia, much triple phosphate, and vibriones, very small and active. At the bottom, there was present much phosphate of lime, a very small quantity of triple phosphate, and many vibriones.

There were also detected a few sporules of fungus, most probably those of the sugar torula.

4th Sample:—This sample was also passed about ten or eleven days since; it is somewhat acid, and the surface is covered with circular tufts, in perfect fructification, of an olive-green fungus, a variety of Penicilium glaucum. The tufts are small and interspersed with several white woolly tufts of larger size, and not in fructification; spreading over nearly one half the urine is another fungus in perfect fructification, the saccharine; this is recognised by the long filaments which spring up on all sides, bearing on their summits the minute spherical heads which are so characteristic of the species. On examination with the microscope, numerous large sporules and threads of the diabetic fungus, as also many stellæ of phosphate of lime, were discovered,

intermixed with the threads forming the thallus of the olive-green tufts of Penicilium glaucum; the thallus of the woolly tufts likewise contained an immense number of stellæ of phosphate of lime.

5th Sample:—Urine passed after dinner, on the *5th* of *September*, clear, of the colour of pale brandy, decidedly acid; specific gravity 1019; colour somewhat deepened by boiling with potash; no result with the copper test.

Examined *7th September*. Still clear and acid, has deposited much mucus, and some oxalate of lime.

Examined *8th Sept.* Turbid, but still acid, a few mucus-like masses near surface.

Examined *11th Sept.* Still acid; a decided scum on surface, composed of the small sporules of the saccharine fungus, vibriones, and a few crystals of phosphate of lime.

Examined *17th Sept.* Alkaline; saccharine fungus fallen to bottom, and still in the state of minute sporules; scum on surface, composed of much phosphate of lime and triple phosphate, with many vibriones. At the bottom of the glass, groups of sporules imbedded in masses of vibriones were detected, also very much oxalate of lime, phosphate of lime, and triple phosphate; the same also adhering to the sides of the glass in large quantities.

6th Sample:—Urine passed early in the morning of the *6th* of *September*, clear, of a pale brandy colour, acid; specific gravity 1022; colour more deepened than in Sample 5, by boiling with potash; the copper test does not afford any evidence of the presence of sugar.

Examined *7th September*. Very turbid, decidedly acid, contains great numbers of octohædra of oxalate of lime, and much vesical epithelium.

Examined *8th Sept.* Urine very thick; cloud-like masses of the sporules of the sugar fungus both on the surface and at the bottom, as also many bubbles of carbonic acid gas.

Examined *17th Sept.* Urine alkaline; colour of urine not deepened by keeping; scum on the surface, composed of crystals of phosphate of lime, a pellicle of phosphate of magnesia, and many vibriones; at bottom of glass, very much phosphate of lime, numerous globules of some urate, a little triple phosphate, vibriones, and a few dark sporules of fungus, perhaps, those of the sugar plant.

7th Sample:—Urine passed after dinner, on the *6th of September*, decidedly acid; specific gravity 1015; clear, and of a pale colour; colour deepened by boiling with potash; no evidence of the presence of sugar afforded by the copper test.

Examined *8th September*. Very turbid, contains much vesical epithelium, but no oxalate of lime.

Examined *10th Sept*. Feebly acid, smell a little offensive, very thick, with large masses of sporules near the surface, a considerable deposit of the same, and many globules of carbonic gas.

Examined *11th Sept*. Scum on surface composed of vibriones, and phosphate of lime; no triple phosphate; urine nearly neutral.

Examined *21st Sept*. No scum; crystals of phosphate of lime floating on surface, and adhering to sides, some compound, with both extremities perfect; triple phosphate, and a very few minute octohædra of oxalate of lime. At bottom, phosphate of lime, triple phosphate, and vibriones. No diabetic sporules of any size.

8th Sample:—Passed after dinner, on the *6th September*, slightly acid; specific gravity 1019.

Examined *8th September*. Neutral, rather turbid.

Examined *10th Sept*. Alkaline, still more turbid; deposit of mucus with much triple phosphate; on surface, a scum consisting of vibriones, and much triple phosphate; no sporules of sugar fungus detected, and no phosphate of lime; the urine is now rather offensive, its colour was slightly deepened by boiling with potash; but the copper test gave no evidence of sugar.

Examined *21st Sept*. Much urate in globules at bottom of glass, with triple of phosphate, but no phosphate of lime.

9th Sample:—Passed *7th September*, at bedtime, nearly neutral; specific gravity, 1016.

Examined *10th September*. Very thick, alkaline; scum on surface composed of vibriones, and triple phosphate, deposit formed of same; no sporules of sugar fungus detected, and no phosphate of lime.

10th Sample:—Passed early on the *7th September*, decidedly acid; specific gravity 1016, clear pale straw colour; colour deepened by potash; copper test gave no evidence of sugar.

Examined *9th September*. A little turbid, contains much vesical epithelium, but no oxalate of lime.

Examined *10th Sept*. Very thick; masses of sporules near the surface, falling to the bottom when the glass is moved; a few bubbles of carbonic gas; phosphatic scum on surface; urine smells rather offensively, but is still a little acid.

Examined *11th Sept*. Scum more decided, composed chiefly of phosphate of lime, with a little triple phosphate and many vibriones; still faintly acid; bulky deposit formed of mucus; the small sporules of the sugar fungus and crystals of phosphate of lime.

Examined *16th Sept*. Urine alkaline; no further development of the saccharine fungus.

Although the colour of most of the above urines was deepened by boiling with potash, yet this increase was not greater than is commonly observed in urines which do not contain sugar. It is usually stated that non-saccharine urine is bleached by boiling with potash. This is incorrect, as shown by me in a paper published in the 'Lancet,' March, 1851.[1] It almost invariably darkens every variety

[1] On the Tests for Sugar in the Urine, 'Lancet,' 1851.

of urine. Thus, in not one of the above samples did either the potash or copper tests betray the presence of sugar.

As scarcely any data exist tending to elucidate the early, and therefore the most important stages of diabetes, it may be useful to give a somewhat detailed description of the symptoms, by which for the last three or four years the case of incipient diabetes referred to was characterised.

CASE.—William F—, æt. 35, of delicate organisation and nervous temperament, but free from organic disease, has for some years suffered considerably from chronic indigestion, as evidenced by frequently recurring attacks of headache and sickness; these were brought on by very slight causes, as any little error or excess in diet; the headaches were particularly distressing, and attended by giddiness and confusion of thought; the vomitings set in some hours after the commencement of the headaches, when these were unusually severe, and occurred as often as once or twice a week; each attack consisted of several successive fits of retching, and sometimes lasted as many as 10 or 12 hours, continuing long after the stomach had been well emptied. Within the last 8 months the headaches and sickness have nearly ceased, but occur still occasionally on any departure from the very temperate and regular method of living usually pursued.

The attacks were worst in summer, milder and less frequent in winter. For the last four or five years the patient has noticed that he passed his urine more frequently and in larger quantity than ordinary, his kidneys acting quickly on the slightest cause, as almost immediately after taking liquids of any kind, especially beer. The characters of the urine have already been described above. He has long also experienced a constant feeling of debility and exhaustion, both bodily and mental; as the appetite was generally good, he was unable to account for this extreme debility, and expressed a conviction that the large quantity of urine eliminated acted as a drain upon his system, the food and drink taken, by stimulating the kidneys, appearing rather to increase the exhaustion than to afford support.

Amongst the peculiar symptoms were the following:

1st. An occasional dry hacking cough without expectoration, and unaccompanied by symptoms of cold; this used to come on about noon, and was attended by slight febrile excitement; it was always removed for the time by food. 2d. Frequent dryness of the lips without positive thirst; this symptom attracted attention long previous to the discovery of sugar in the urine, and excited the suspicion that the case might possibly be one of incipient diabetes. 3d. Very great susceptibility to changes of temperature and weather; while rain, or the least dampness of the atmosphere, produced considerable depression; the heat of the sun seemed to inflame the blood, and to induce in it a state of fermentation.

The above symptoms, prior to the detection of the sugar, were set down to indigestion and the phosphatic condition of the urine; it is now clear, however, that they were mainly attributable to the sugar, the presence of which in the urine shows that the primary assimilative functions were very greatly at fault.

The patient attributed his bad health to excessive mental labour and long-continued anxiety. For some weeks past he has relaxed somewhat from study, has taken more exercise, the diet has been regulated, meat being allowed twice a day; as the result of all which, the health has considerably amended.

We have then occurring in the urine in different and very opposite states, two distinct species of fungus, the one being characteristic, to some extent, of the presence of albumen, and the other of sugar; but since the conditions necessary for the development of Penicilium glaucum all exist in saccharine urine, the only difference being the superaddition of sugar, we have next to ascertain whether the two species do not sometimes occur together in the same urine.

As might almost have been anticipated, the result of observation on this point is, that they not unfrequently occur together.

When the amount of sugar present is but small, the two fungi go on developing themselves almost in equal ratio, each presenting its own distinctive characters, so that when they have attained their full development, part of the surface of the urine will be occupied with patches of the true saccharine torula, and part with those of Penicilium glaucum. In some cases, even the same tufts may be formed of the two species combined. (Pl. III, fig. 4.)

When, however, the quantity of sugar is considerable, the saccharine torula is developed with such rapidity and in such quantity as to outstrip the other species; and it is only when the fermentation has nearly come to an end, that Penicilium glaucum comes into view, and proceeds in its development.

We have, in the next place, to consider very briefly the chemical changes which ensue in saccharine urine placed under the three conditions already described, viz. free exposure to the air, partial exposure, and complete exclusion.

In all the specimens of saccharine urine freely exposed to the air, the following changes have ensued: the sugar has disappeared, carbonic acid has been evolved, and alcohol formed; of the alcohol part escapes into the air, diffusing a vinous odour, and part is converted into acetic acid. As the conversion of the sugar proceeds, the specific gravity of the urine becomes greatly lessened.

In the specimens partially exposed to the atmosphere, the urine, after a time, presented a gelatinous appearance, possessed a smell like sour milk, and was strongly acid; on analysis it was ascertained that the sugar had disappeared, that a small quantity of alcohol was present, and that the acidity was due to an abundance of acetic acid. In one or two of the samples, large quantities of oxalic acid in combination with lime were detected. As the saccharine fungus was imperfectly developed only, it is probable that in this case the greater part of the sugar passed directly into acetic acid.

In the specimens from which the air was excluded, as there was only a slight development of the sugar fungus, so was there scarcely any formation of alcohol; nevertheless, the sugar disappeared, and it was found on analysis to have

become converted into lactic acid, a small quantity of butyric acid, and what appeared to be aldehyde, from its smell and property of slightly reducing the oxide of silver, and giving a brownish-yellow coloration with liquor potassæ.

These several transformations of sugar are interesting, if not important; it has usually been considered that saccharine urine, when kept for any length of time, always undergoes the vinous fermentation; the lactic, acetic, butyric, and oxalic acids sometimes formed, as well as the circumstances which determine their formation, having been in general overlooked.

From a review, then, of the whole of the facts and observations above described, relating to the development of torulæ in saccharine urine, the following conclusions may be deduced:—

1st. That there is developed in saccharine urine, freely exposed to the air, a distinct species of fungus, which occurs in no other condition of that excretion.

2d. That this fungus is identical with the yeast plant.

3d. That it passes through three stages of development, any one of which is distinctive of the species.

4th. That since it is sometimes developed in urine in cases in which the potash and copper-tests fail to detect the presence of sugar, and in which, therefore, the quantity of sugar is not very considerable, it affords a most valuable and important test, and furnishes us with the means of detecting diabetes, even in its earliest stages.

5th. That the conditions necessary for its development are—free exposure to the air, an acid liquid, nitrogenous matter to act as a ferment, grape sugar or glucose, and a moderate temperature.

6th. That it may be developed at will in any sample of urine which is sufficiently acid, by the addition of a few grains of grape sugar.

7th. That when specimens of saccharine urine are imperfectly exposed to the air, the development of the fungus is incomplete only.

8th. That when the atmosphere is entirely excluded, no development of the fungus occurs.

9th. That in some few cases, where the quantity of sugar is very small, the fungus will cease to grow after having passed through the first stage only of its development, in consequence of the sugar, all having become converted into alcohol and carbonic acid.

10th. That sugar may be present in some very rare cases in small quantity, and yet the torulæ fail to be fully developed in consequence of the urine not possessing the necessary degree of acidity.

11th. That in such cases it is probable the development might be ensured by the addition of small quantities of phosphoric acid, or of a solution containing carbonic acid.

12th. That the presence of this fungus indicates the vinous fermentation, its development being accompanied by the disengagement of carbonic acid and the formation of alcohol.

13th. That the power of the fungus in aiding the transformation of the sugar is limited to the period when it is in the condition of sporules or yeast, the thallus and aërial fructification exerting no influence over the change.

14th. That in those cases in which the fungus is only partially developed, in consequence of imperfect exposure to the atmosphere, the sugar is converted chiefly into acetic acid, but a portion sometimes, also, into oxalic acid.

15th. That where the fungus is not developed at all, in consequence of the exclusion of the atmosphere, the sugar is transformed into lactic, acetic, and butyric acids, and also probably aldehyde.

16th. That since, in saccharine urine, the conditions requisite for the development of Penicilium glaucum exist, that species is likewise frequently met with in such urine.

17th. That in very many of the specimens of urine obtained from the patient labouring under diabetes, in a mild form, large quantities of crystallised phosphate of lime were detected.

Postscript, *received January* 11*th*, 1853.—Since my paper on the Development of Torulæ in the Urine was read before the Royal Medical and Chirurgical Society, I have been so fortunate as to meet with another case, in which the urine threw down, on being allowed to stand for some time, an abundance of crystals of phosphate of lime, and which also contained some sugar, as shown by the development of the sugar fungus. This case affords, therefore, further and strong proof of the relation which I suggested might possibly be found to exist between crystals of phosphate of lime in the urine, and small quantities of sugar. The particulars of the case are as follows :—

Case.—Mrs. T—, aged 32, of delicate constitution and nervous susceptible temperament, subject to dyspepsia, married, and has three children, the youngest only three months old. Attention was directed to the urine in consequence of the intense pain experienced on ceasing to micturate. The only sample of urine examined, and for which I am indebted to my brother, Dr. Hassall, of Richmond, was passed on the 19th of November; it was of specific gravity 1031, very acid, contained a large quantity of some pink urate, very many crystals of uric acid, and some octohædra of oxalate of lime; there was no albumen, nor could sugar be detected by means of Trommer's test.

Examined 22*d November*.—The urine was still acid, and a cloud of vaginal epithelium had fallen to the bottom of the glass.

Examined 27*th November*.—It was still acid, and the surface was covered all over with circular patches of Penicilium glaucum in the state of sporules. Under the microscope there was discovered, mixed up with the sporules, an abundance of crystals of phosphate of lime.

Examined 7*th January*.—Urine alkaline; there was a scum of Penicilium in perfect fructification covering the whole surface of the urine, and mixed up with this were immense numbers of globules of the urate and crystals of phosphate of lime, triple-phosphate, and oxalate of lime, together with some sporules and thallus of the sugar fungus.

POSTSCRIPT, *received August 27th*, 1853.—Since the above communication was presented to the Royal Medical and Chirurgical Society, I have on several occasions met with crystals of phosphate of lime in connection with the saccharine torula. The fact, therefore, that some close relation exists between these crystals and sugar in the urine may now be considered to be fully established.

NOTE.—It may be well to state that the credit of establishing the real nature of yeast is due to Cogniard-Latour. In 1835 and 1836 he communicated to the *Société Philomathique* some researches on Ferments, which were afterwards published in a journal called 'L'Institut.' In 1837 he presented to the Academy of Sciences his "Memoire sur le Fermentation Vineuse," which was published in the 68th volume of the 'Annales de Chemie et de Physique,' 1838.

Fig. 1.

Circular Sporules of Penicilium glaucum.

Fig. 2.

Oval Sporules of Penicilium glaucum. 220 diam.

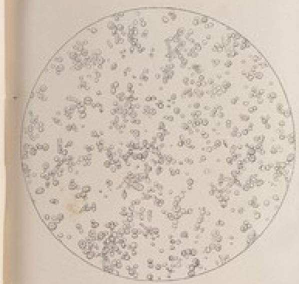
Fig. 3.

Sporules of Penicilium glaucum passing into filaments.

Fig. 4.

Thallus of Penicilium glaucum showing the Vesicular Enlargements 220 diam.

Fig. 1.



Sporules of Sugar Fungus in earliest stage of developement. 220 diam.

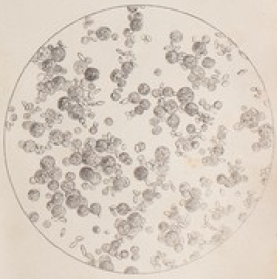
Fig. 2.

Sporules of Sugar Fungus in earliest stage of developement. 420 diam.

Fig. 3.

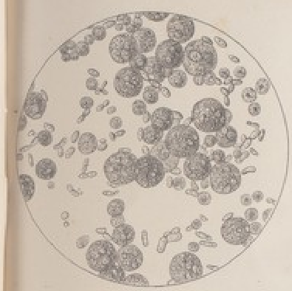
Sporules of Sugar Fungus also those of Penicilium glaucum with Crystals of Uric Acid. 220 diam.

Fig. 4.



Variety of Sporules of Sugar Fungus with those of Penicilium glaucum 220 diam.

Fig. 1.



Variety of Sporules of Sugar Fungus with many of Penicilium *glaucum* 400 diam.

Fig. 2.

Thallus and Sporules of Sugar Fungus 220 diam.

Fig. 3.

Thallus and Sporules of Sugar Fungus with crystals of oxalate of lime also Vesicles of the Same 170 d.

Fig. 4.

Penicilium *glaucum* in Perfect Fructification with Filaments and Sporules of Sugar Fungus 220 diam.

Fig. 1.

Incipient Thallus of Penicillium glaucum
with Groups of Sporules. 220 diam.

Fig. 2.

Penicillium glaucum. Perfect fructification 220 diam.

Fig. 2.

Sugar Fungus in Perfect Fructification. 60 diam.

Fig. 1.

Thallus and Sporules of Sugar Fungus. 220 diam.

Dr Parkes
with Dr Acland's compliments

REPORT

ON THE

GENERAL SANITARY CONDITION

OF

COWLEY INDUSTRIAL SCHOOL.

BY

HENRY W. ACLAND, M.D., F.R.S., &c.

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1863.

Cowley Industrial School is the School for Pauper Children attached to the Oxford Union. It was intended to be a School for the surrounding district. Hitherto this desirable object has not been attained.

OXFORD,
March 12, 1863.

To the Guardians of the Poor within the City of Oxford.

GENTLEMEN,

I have the honour to acquaint you that, in conformity with the Resolution of the Board of Guardians communicated by your Chairman to me on February 25, I have examined the Industrial School at Cowley.

By the courtesy of the Chairman and of your Medical Officer I have visited it both with them and by myself, and it gives me pleasure to add that I have received the most ready assistance from the resident Officers of the Establishment.

It is hardly necessary to remark that the words of the Resolution, with I doubt not the fullest intention, imposed on me the duty of a full enquiry. To report "generally upon the sanitary condition" of a school is to give an opinion on all circumstances which can affect the health of the inmates: and this opinion is valueless, unless it be accompanied by a statement as to whether any and what alterations are desirable, in order permanently to secure the children's physical welfare.

There is in the Cowley School a condition of an anomalous nature, which makes it difficult to frame satisfactory recommendations while that condition lasts.

I allude to the fact that it was planned for more than 200 children and that there are now but 83. Consequently the capabilities of the Institution are undeveloped. This being so, it is not easy to conduct the internal arrangements for industrial work so as to ensure at once economy, education, and health.

I will endeavour to state clearly the points which called for investigation, and I will name under each head such modifications as appear to me desirable for the health of the children without defeating the objects of the founders of the School. After this has been done I shall venture to lay before you some of the general principles which have guided me in the observations I shall have made.

I found on the 26th of February among eighty-three children no less than thirty-four cases of skin disease. There were two distinct disorders—one a disease of the scalp, the other a general affection resembling Scabies in several stages, but so deficient in some of the ordinary characters as to make a positive conclusion as to its nature at first difficult. I have now had time to make the investigation necessary to arrive at this conclusion, and by signs which cannot be mistaken, viz. the detection of the ova of the *Sarcoptes hominis* (which I believe these ova to be), the presence of Scabies is established, however much it is masked by other serious pustular eruption and by boils. I have conferred with your Medical Officer on the medical management of these cases. They, as you know, have proved very tedious; and though often cured have often again relapsed.

There was, besides, in many children evidence of languid circulation, unfavourable to the development of either body or mind.

These conditions do not imply necessarily either neglect or mismanagement in any one department. But they do of course imply, either, that in one or more departments the arrangements are imperfect, or else, that the children themselves are incapable of attaining to health. It became therefore my duty to look into every particular of the scheme of the School. I may as well say at once that, on the whole, the management of the School is encouraging and satisfactory.

To point out by what kind of management we may hope to secure freedom from disease, and the future health of the children, is the object of what follows.

The sanitary condition of the School generally may be considered under the heads of

1. The Building and its Site.
2. Clothing and Cleanliness.
3. Food.
4. Occupations.
5. Hospital Accommodation.
6. Management and Expenditure.

1. THE BUILDING AND ITS SITE.

The history and general character of the School-buildings at Cowley are too well known to you to require minute details from me.

The house has a southern aspect, and stands on a small plateau of the Oolite, with gentle slopes to the South, the North, and the East. If the adjoining fields were in possession of the Guardians, they would afford ample scope for agricultural operations to any extent that the Guardians could require. But the ground most available for these purposes as regards the children —that is, the ground with the southern slope sheltered from the north—is not, I am informed, the property of the Guardians; whereas the northern plateau, exposed to all keen winds and quite unprotected, is their only available tillage-ground. This is, I think, a cardinal misfortune.

The arrangements of the interior of the dwelling are sufficiently good; the rooms are lofty, airy, capable of excellent ventilation, and of adequate warming by open fireplaces. The drainage demands attention. Soil-pipes are said to leak into the house, and the water supply is scanty in the Closets. The Drains moreover, so Mr. Bruton informs me, ought to be examined, and before this Report is presented, will have been inspected.

It is proposed to convey the sewage away from the present cesspools to a sewage distribution tank. Under proper management, and if the soil be sufficiently friable to absorb the liquid and to mix with the solid refuse, there is, I am inclined to think, no danger to be apprehended to the health of the house, from this change. Upon this point, and upon the question of how much sewage can be most profitably distributed on a given area, it is premature to speak with certainty[a]. The Guardians will, however, be justified, both on sanitary and economical grounds, in making the attempt of so re-arranging their drains, and by this method they will help to familiarize the agricultural lads with practical operations of this nature. It would be more easy to distribute the house sewage on the east and south, than on the plot now in hand to the north. If it be distributed to the north it must be pumped to a proper level. Already the children have, to say the least, enough work.

I have not felt called upon to examine the general

[a] See Reports of the Sewage Commission, 1858 and 1861, and Report of Select Committee on Sewage of Towns, 1862.

character of the shell of the building. But with respect to the ground-plan it appears to me that in two particulars it is defective.

(a) The Play-yards are to the north, and though partially sheltered by low buildings from the northerly winds which come unbroken over the plain, the children are during the whole winter deprived by the mass of the school-building of one essential of health — sunshine.

One of the first remedial measures should be a Playground to the south of the School.

(b) The Lavatories have no covered communication with the main body of the building.

It may be said generally of the several departments that they are airy, roomy, and suitable to their several purposes.

2. CLOTHING AND CLEANLINESS.

These two are considered together, as they are intimately connected.

The bleak position of the School, the absence of all protecting vegetation, the northern aspect of the playgrounds, the low physical type of the children, require that very special attention should be given to the Clothing; both in respect of its quality and quantity. In each of these the children appear to me to be treated with judgment; and their general appearance is creditable to those to whose care they are committed.

The Clothes are in good order and of substantial quality. I find that flannel next the skin is not worn, nor should I lay down as an absolute rule that it is necessary. But if it be not necessary for *all*, it is the more requisite to pay attention to the children individually, and to provide flannel waistcoats for some; but I believe as a rule that up to the age of seven they should have it. I shall have to state hereafter some general principles applicable to dress as to other subjects, so that I need only add now, that when the circulation is languid, when chilblains are frequent, when the physical type is markedly low, and especially when these characters co-exist in the youngest class of children, then flannel should be always ordered. For the younger children, up to five, flannel gowns are desirable for a night-dress; for the older this is unnecessary.

Essentially connected with the Clothing is the Cleanliness of person, of apparel, and of bedding.

The experience of the great Metropolitan Workhouses shews that low type children require more attention to cleanliness to keep them in health than children of a higher grade and of finer breed; and I make this remark at once to screen myself from the charge of over-refinement in what I am about to say. With all possible care, such children, removed from home and collected in masses, can scarcely be kept clean enough to secure such health as shall make them robust. Considerable attention is paid at Cowley to this point. The children all have a cold or warm bath once a week. This may be advantageously extended to twice. The general washing should be down to the waist daily, with an ample supply of water. It is indispensable that the washing-troughs should be renewed on a different plan. Trusty elder children should be responsible under direction for the thorough cleanliness of the lavatory and of the washing basins.

The Bed-linen and Beds have next to be considered. Whenever a bed is soiled the ticking should be removed and sent to the wash, and the flock be air-dried and

occasionally cleaned; or, which is better, the whole bed should be steamed in a closed chest, and afterwards dried in the hot-air closet. No sheets should be used for more than a fortnight. If soiled, they should be changed at once. If children are carelessly or wilfully unclean they should be punished, and should sleep on straw-chip beds, the straw being burnt as soon as soiled[b]. Blankets are to be washed as they appear to become dirty, or, at all events, once a-year. The boys should have their linen changed at the least twice in the week if they sleep in their day linen, once a week if they have night linen provided. Fire should be occasionally lighted by rotation in the dormitories for a few hours.

On occasion of the present enquiry all the clothes and all the bed-linen of every child that has had a cutaneous affection, or any clothes or bed-linen that have been used by any that have it, should be forthwith steamed or boiled, and fresh clothes should be served out as the children are reported to be cured. Meanwhile, there being ample space for the purpose, the children affected are to be kept separate till the cure and change of clothes has been completed.

3. FOOD.

For clearness' sake I append in the following table the diet which I should suggest for the present, stating the quantities in their *weekly* amounts. The upper line is the present dietary: the lower that which it is proposed to substitute for it.

[b] Mr. Tufnell tells me that cocoa fibre, which can be washed and replaced, answers well.

TABLE

Shewing the present and the proposed dietaries, in pints and ounces. The quantities are those allowed weekly.

COWLEY SCHOOL.	Bread.	Potatoes.	Greens, Turnips, or Carrots.	Mutton.	Beef.	Rice Pudding.	Butter.	Milk (pints).	Soup (pints).	Suet Pudding.	Porridge (pints).	Cheese.
Ages, 2 to 5.												
Present diet	61	18		6		8	1¾	5¼	1	8	0	0
Proposed diet	**61**	**16**	**16**	**6**	**6**	**8**	**3½**	**7**	**0**	**0**	**0**	**0**
Ages, 5 to 9.												
Present diet	78	24		9		0	1¾	1¾	2¼	10	5¼	0
Proposed diet	**88**	**20**	**20**	**7**	**7**	**10**	**3½**	**5¼**	**0**	**10**	**0**	**0**
Ages, 9 to 16.												
Present diet	98	24		12		0	0	3½	3	12	7	7
Proposed diet	**110**	**20**	**20**	**8**	**8**	**0**	**3½**	**3½**	**1**	**12**	**0**	**7**

The general principle upon which the changes recommended are based will be found to be an increase of meat, especially for the youngest class; an addition of green food; an increase of milk in the two younger classes; an addition to the bread of the two older classes; the abstraction of porridge from the two elder classes, and of suet pudding from the infants.

Experience has shewn, and will, I believe, in this case also prove, the value of such a Dietary here respectfully proposed to you. But in my judgment, no Dietary, however excellent, will suffice, unless accompanied by open-air exercise, and by, as far as can be secured, such mirthful life and child-like elasticity as can be obtained in a system necessarily and confessedly not favourable to the best development of the body and mind of a child. No diet whatever which is monotonous is safe for children. A little skilful management in varying the flavour and mode of cooking will often secure the

assimilation of a diet not absolutely so nutritious, as one which is left untouched in consequence of a natural instinct that demands variety.

4. OCCUPATIONS.

The occupations generally proper for Industrial Schools are now so well defined as to require no elucidation here, save in so far as local or special circumstances bearing more directly upon health may tend to suggest modifications.

The half-time system gives ample opportunity for out-of-door work or play, if both of a suitable description be provided. Health being all in all to a working lad, and vital power being generally deficient in pauper children, sedentary industrial work, such as shoemaking and tailoring, are among the least desirable for health. Carpentery, stable or farm work, smithing, gardening are among the best for the boys, if they be not overtasked; cooking, housework, washing are suitable for the girls. These for the most part develope the muscular system, and exercise usefully the mental qualities. Smithing is named as specially desirable, because an increasing number of lads can find places in connection with agricultural or other smaller steam engines, which are being largely brought into use throughout the country. A small steam engine for pumping water would, if the plan of irrigation with the sewage be carried out, be useful for the House; the man who managed it might be an industrial teacher in iron-working. A greater supply of water is wanted than the work of the lads should be expected to produce; and, as is the case at Annerley, the steam boiler might supply hot water and steam heat for the laundry, the kitchen, and the baths—one man superintending the whole and teaching the lads[c].

It has been already said that the play-grounds should be in the sun to the south: they might be fitted with plain and circular swings, and Norwegian poles, at trifling expense, and from this one change very good results might be anticipated.

The girls at Cowley are not quite so easily provided with useful and healthful occupations as the boys. They are not strong enough for washing, excepting in the case of a few, who can do the lighter parts. They may aid in the kitchen to some extent; but the wholesale cookery of a large establishment is comparatively useless to them afterwards. Two or three might with advantage be taught in turn to prepare on special cottage grates smaller portions of diet. They would soon acquire handiness and knowledge which would be of real use to them in after life, whether in service, or in their future homes[d].

I am but too well aware of the difficulty of organizing such details in a small establishment; but I feel it a duty nevertheless to record them because of their bearing on the cheerfulness, life, and so on the health, of the inmates. Could not unpaid help be found to aid in superintending work of this kind?

I will only say further with respect to the occupations

[c] I submit to the Guardians whether it might not be worth while to consider this addition to the establishment before deciding on the position of the sewage tanks. Should the School be much increased, there would be little doubt of the value of the arrangement.

[d] This arrangement was proposed for the convalescents of the Hospital in this place several years ago. If every provincial Hospital would act on it, in a very few years economical and palatable cottage cookery might be practised in thousands of poor homes.

that it has been found that Music is a source of the greatest pleasure, and, when on a large scale, of profit also to district workhouse schools. Of pleasure, because a cheerful band keeps up, as is well known on board ship, an elasticity attained in no other way; of profit, by training boys to be fit to enter good Bands. That can be only partially done under ordinary circumstances in a small school: but if music be attempted care should be taken to cultivate cheerful secular music as well as devotional.

5. HOSPITAL ACCOMMODATION.

The Hospital is to the north of the main buildings, exposed on all sides. The window in every ward faces the north; the passages only have a south aspect. The wards are inconveniently small. It is now difficult to make it a satisfactory building in any way. It would be better if certain partition walls were removed, and windows made to the south. In such a situation the wards ought to have been placed east and west. I am informed that diarrhœa arose some time since from a temporary defect in the drains, but this has been remedied and the illness has ceased. The children are well cared for by the Nurse; but her duty is now heavy.

6. MANAGEMENT AND EXPENDITURE.

At the outset I ventured to say that certain general principles would be stated as those that had guided me in this Report; and they will explain why I have entered on topics which may at first sight seem to be only collaterally connected with health.

The *first principle* of a Pauper School is, it may be presumed, to train the children in such a way as to make them so useful and so independent that they might be raised from the pauper class, and in future kept off the rates. Whatever falls short of this is at once scant charity and bad economy. If this be admitted, there follows *a second principle*, viz. that the low condition of the children of this class, who have no homes and are without hope, requires greater care, and in some respects higher training, physical and mental, than is sufficient for a class above them, and almost necessarily involves a larger proportional expenditure. I do not see how the necessary training is to be had in any school without considerable expense; and expense less than is sufficient is a simple waste.

It were unbecoming in me to illustrate these maxims at length where they are well understood. At the same time, the question referred to me could not be considered with advantage between us, unless you knew the point of view from which the School was considered by me as your medical adviser on this occasion. I entertain no doubt that a somewhat higher scale of food and of cleanliness and of care is required for these children, in order to keep out the disease from which they have so long suffered. It is in itself, as I said at the outset, an index of a low state of vitality, or of cleanliness, or of food, or of care, or of all together. If any of the Guardians should point at the existing dietary and the general scale of comfort, and remark that they are even now far higher than these children would have in their own homes, were they not of the pauper class; I can only answer that, true as that is, the loss of the freedom of home, the absence of the care of parents, and the deadening influence of unexercised affections, entirely counterbalance the supposed advantages in food, and air, and clothing; and that had the Guardians been wholly satisfied with their condition they would not have required the present inspection.

There is nothing in the condition of the children which leads me to doubt the soundness of the principle on which the Industrial School was founded. That it has hitherto failed in practically becoming, as was intended, a District School, is unfortunate; and yet it is no objection to the principle of such establishments. The nearer, indeed, it can be brought to its intended condition of a *large* school the better. Well-paid Officers with ample help when required, liberal diet, cheerful amusements outside the building, will keep the Hospital clear, and give good material back to society and independence.

At the same time, I beg leave to guard myself against even the appearance either of advocating the opinion that District Schools are in all places the only, or even the best, method for the education of pauper children; or of objecting to orphan pauper "Homes," if under adequate inspection, and to all Workhouse Schools. I have not been called upon to enter on those questions, but only to discuss the "Sanitary condition generally" of the Cowley Industrial School, which was devised for a District School; and I have had to consider whether there be causes for low health inherent in it. I think that there are no such inherent causes. If the judgment of the Guardians should lead them to conclude, on examining the details of this Report, that any alterations are desirable for the purpose of checking the tendency to low pustular affections for so long prevalent there, the most important points will be suggested in the following summary of what has been stated above. They are the general conditions requisite for the health of such inmates, in such a building, and under such conditions as those you have to regulate.

The Guardians will no doubt notice that I have not gone into financial statements, such being wholly beside the question of what it may be desirable to do, if it be possible. But then I take leave to add that I have suggested no expense but what I believe to be reasonable and judicious, and, should the School increase, also remunerative.

I. As respects the Dwelling and its site.

1. The southern slope should be in the hands of the Guardians.
2. The sewage may be turned on the land.
3. Play-grounds to the south should be provided.
4. The lavatory arrangements to be remodelled.

II. Clothing and Cleanliness.

Flannel to be provided.
Beds and clothes to be *steamed* as required.
Linen frequently changed.

III. Diet,

To be somewhat increased, and to be varied.

IV. Occupations.

Tailoring and Shoemaking not in themselves so desirable as employment out of doors or not involving a sitting posture, such as Carpentry, Smithing, Gardening, &c.
Cheerful recreations to be encouraged as such: music, drum and fife band, drilling, walks into the country.

V. Hospital,

If School increases, to be remodelled.

VI. Expenditure.

Experience has shewn that liberal expenditure and full numbers are essential for maintaining the vigour of children in District Schools, and for securing the ultimate objects of the Institutions.

It may be satisfactory to the Guardians to know that, notwithstanding the suggestions which it has been my duty to submit to their notice, I consider their School

capable of securing the highest sanitary condition for a considerable number of the class of children for whom it was destined.

It is a pleasure and a duty to acknowledge the ready kindness with which Mr. Carleton Tufnell, the accomplished Inspector for the Privy Council, has accompanied me over all the details of the Central London and North Surrey District Schools. I am greatly obliged to the Rev. S. V. Edwards, the Chaplain, to Dr. Coster, the Medical Attendant, and to the Superintendent of the Central London School: to the Rev. O. J. Vignoles, Dr. Wilkinson, and Mrs. Smith, of the North Surrey School; as well as to Mr. Harries of the Poor Law Board. Without the minute information these experienced persons were so good as to give me in the most obliging manner, I could not have decided without a much longer enquiry on several of the details that are here hinted at rather than fully described.

The Guardians are probably acquainted with the mass of information on the subject contained in the Evidence and Report of the Education Commission, in several volumes of the Poor Law Reports, and in that useful publication, the Journal of the Workhouse Visiting Society. It would have increased these few pages to unwieldy dimensions had I quoted these documents in detail on the several points I have named; or had I discussed in full all the reasons for or against what has now been advanced.

I have the honour to be,
Gentlemen,
Your most faithful Servant,
HENRY W. ACLAND.

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DES SUCRES

PAR

A. NAQUET

DOCTEUR EN MÉDECINE, LICENCIÉ ÈS SCIENCES PHYSIQUES.

PARIS

F. SAVY, LIBRAIRE-ÉDITEUR,

RUE HAUTEFEUILLE, 24.

1863

DES SUCRES

En commençant cette étude, il ne serait pas inutile de définir le mot « *sucres* » ; mais cette définition est malaisée, presque impossible. Tout mot qui s'applique à un ensemble de phénomènes, à une série de corps étroitement liés entre eux par un rapport, un caractère commun, peut être déterminé, précisé. Lorsque ce caractère manque, la définition devient impraticable, la rubrique arbitraire, et le groupement incertain.

C'est ce qui a lieu pour les corps dont nous allons nous occuper.

Les corps connus sous le nom de *sucres* ne forment point une famille naturelle de composés organiques. Leurs propriétés se retrouvent dans d'autres corps qui ne sont point rangés sous cette dénomination. Si l'on prenait pour base de groupement un de leurs caractères physiques, la *saveur*, ou une de leurs propriétés chimiques, la *fermentation*, il faudrait considérer comme un sucre la glycérine, qui jusqu'ici n'a pas encore été étudiée sous ce nom. Bien plus, la fermentation commune aux sucres et à la glycérine, ainsi que l'a démontré M. Berthelot, ne l'est point à l'eucalyne et à l'inosite, que l'on accepte pourtant comme des principes sucrés. Il en serait de même si l'on partait du fait que les sucres sont des alcools polyatomiques ; le glycol et la glycérine devraient rentrer sous la rubrique adoptée. Et si l'on n'envisageait que leur hexatomicité, on serait obligé de supprimer du groupe la pinite et la quercite, qui sont, comme on le prouvera plus loin, des alcools penta-atomiques, et l'érythrite qui est un alcool tétra-atomique. Comme on le voit, nous n'avons aucun moyen de donner une définition exacte des sucres. Nous nous bornerons donc à examiner comment tous les corps ainsi désignés ont été classés dans cette famille artificielle, et à les énumérer.

Le premier de ces corps qui ait été connu est le sucre de canne, d'un usage journalier; on l'a confondu longtemps avec le principe sucré des fruits acides. Ce n'est que plus tard qu'on a pu constater la différence des propriétés qui distinguent ces deux corps. Plus tard encore, on les a analysés, et on a trouvé qu'ils n'avaient pas la même composition. Ils contiennent cependant chacun l'oxygène et l'hydrogène, en proportion suffisante pour former de l'eau. Ils sont plus hydratés que l'amidon et la cellulose, et subissent sous l'influence de la levûre de bière, directement ou indirectement, la fermentation alcoolique. Ce caractère commun les fit considérer comme appartenant à un même groupe. On connaissait aussi un autre composé de saveur sucrée, la mannite, qui représente un hydrate de carbone, avec léger excès d'hydrogène, mais avec lequel on n'a pas su pendant longtemps produire la fermentation alcoolique. Gerhardt n'hésita pas à classer ce corps à côté des deux précédents; se basant sur certaines métamorphoses compliquées, telles que leur transformation en acides saccharique ou mucique lorsqu'on les traite par l'acide azotique, en acide propionique et acétique lorsqu'on les traite par l'hydrate de potasse fondu. Plus récemment, M. Berthelot, en démontrant que la mannite, comme la glucose, constituent des alcools polyatomiques, et en obtenant la fermentation alcoolique au moyen de la mannite, a rendu plus étroits les liens qui unissent ces composés.

Le sucre de canne, la glucose et la mannite se sont donc trouvés accolés. Comme à chacun de ces corps correspondent des isomères, le nombre des sucres est devenu assez consi-

dérable. La mannite se rattache à un composé moins hydraté qui en dérive, la mannitane. M. Berthelot, voyant un rapport intime entre ce corps et certains principes isomères, tels que la pinite et la quercite, a fait rentrer ces composés dans la classe des principes sucrés. Enfin l'érythrite, qui ne fermente pas, mais que l'on a prise pendant quelque temps pour un alcool hexa-atomique, s'est trouvée, à cause de cela, rangée parmi les sucres comme l'inosite et l'eucalyne, qui ne fermentent pas non plus, mais qui sont isomères avec la glucose, et jouent, comme elle, le rôle d'alcools. Il ne restait plus qu'un pas à faire pour y ajouter les glycérines et les glycols; mais alors il n'y aurait plus que des alcools polyatomiques; les sucres n'existeraient plus.

Nous continuerons donc à donner le nom de *sucres* à un ensemble de corps solides, le plus souvent cristallisables, jouant le rôle d'alcools d'atomicité différente, simples ou condensés, d'une saveur sucrée, susceptibles, la plupart, de subir la fermentation alcoolique. Ces composés sont : le sucre de canne ou saccharose, la mélitose, la mélézitose, la tréhalose et le mycose, la parasaccharose, la lactose, la glucose, la maltose, la lévulose, la galactose, la mannitose, l'inosite, la sorbine, l'eucalyne, la mannite, la dulcite, la pinite, la quercite, l'indiglucite et l'évonymite. A ces corps, M. Berthelot ajoutait la mélampyrite, qui vient d'être reconnue identique avec la dulcite.

De tout ce qui précède, il résulte que le mot *sucre* a pris une plus grande extension, et qu'il a perdu de sa netteté; mais au moins tous ces corps qui, sous cette dénomination, étaient, il y a une quinzaine d'années encore, classés sans ordre dans les traités de chimie, peuvent aujourd'hui entrer dans les cadres d'une classification régulière, à la condition cependant de n'y pas former un groupe distinct et d'y avoir chacun la place qui lui convient. Aussi notre premier soin sera-t-il de rechercher les caractères qui les différencient, ou qui leur sont communs, afin de pouvoir les subdiviser en groupes naturels ; et tout d'abord il nous faut étudier d'une manière générale leurs réactions.

Chaleur. — Sous l'influence de la chaleur, les sucres fondent et se modifient ; si l'on continue à chauffer, ils produisent ainsi des matières ulmiques, et finalement du charbon, en même temps qu'il se dégage une foule de produits gazeux ou volatils, tels que : le gaz des marais, le furfurol, l'acide acétique, l'aldéhyde, l'acétone, etc. Lorsqu'on ajoute à l'action de la chaleur celle d'un alcali puissant, comme la potasse, il se produit de l'acide carbonique, du gaz oléfiant, de l'hydrure d'éthyle, de la métacétone, et si l'on n'élève pas trop la température, des acides acétique et propionique.

Acides. — S'ils sont étendus et qu'ils n'agissent que pendant un temps relativement court, ils hydratent certains sucres, qui se transforment ainsi en des sucres nouveaux, et ils n'agissent pas sur d'autres ; si leur action se prolonge, au contraire pendant longtemps, ils transforment les sucres en une série de composés acides dont les premiers termes sont solubles, et les derniers insolubles et humoïdes. Si les acides sont forts et concentrés, ils transforment les sucres en composés ulmiques. Enfin dans certaines conditions déterminées, ils se combinent aux matières sucrées, en éliminant de l'eau de la même manière qu'ils se combineraient à un alcool.

Alcalis. — Tous les sucres sont susceptibles de s'y combiner. Les combinaisons qui se produisent présentent, selon les corps d'où elles dérivent, divers degrés de stabilité. Si l'on chauffe en présence de l'eau à une température suffisamment élevée, celles de ces combinaisons qui sont le moins stables, on obtient les sels alcalins d'une série d'acides dont les premiers termes sont solubles et les derniers humoïdes, et qui paraissent se confondre avec ceux qui proviennent de l'action prolongée des acides.

Oxydants. — Sous l'influence des oxydants on a pu, soit priver les sucres les plus hydrogénés d'hydrogène et les

transformer en sucres moins hydrogénés, soit substituer une certaine quantité d'oxygène à une quantité équivalente d'hydrogène, et obtenir des acides dont les plus oxydés parmi ceux qui conservent intact le groupement primitif sont l'acide saccharique et l'acide mucique. Si l'on pousse plus loin l'oxydation, on obtient de l'acide oxalique, et, dans certains cas, des acides racémique ou tartrique.

La production de l'acide saccharique ou de l'acide mucique, acides isomères, mais bien différents par leurs propriétés, est un caractère qui permet de ranger les sucres et même les substances neutres, comme l'amidon et les gommes, én deux classes dont les termes se correspondent. Voici un tableau que nous empruntons presque en totalité à M. Berthelot, et qui indique cette division :

Principes qui fournissent de l'acide mucique.	*Principes qui fournissent de l'acide saccharique, ou tout au moins qui ne fournissent pas d'acide mucique.*
Gommes insolubles.	Ligneux amidon.
Gommes solubles.	Dextrine.
Mélitose.	Sucre de canne.
Lactose.	Tréhalose, mycose, mélézitose.
Glucose lactique.	Glucose, lévulose.
Dulcite.	Mannite, pinite, quercite.

Ferments. — Sous l'influence de la levûre de bière, la plupart des sucres peuvent se résoudre en un certain nombre de produits dont les principaux sont l'alcool et l'acide carbonique, mais parmi lesquels on trouve encore l'acide succinique, l'acide acétique et la glycérine.

Les propriétés que nous venons de passer en revue, et dont aucune n'est tout à fait générale, permettent de grouper les sucres en quatre grandes classes.

La première classe renferme des sucres dont le plus grand nombre contient un excès d'hydrogène ; ce sont des corps qui ne fermentent pas ou dont la fermentation n'a lieu que dans des conditions toutes particulières. Ces corps ne réduisent pas le tartrate cupro-potassique; les alcalis ne les altèrent pas à 100°; l'acide sulfurique concentré ne les charbonne pas à froid, et leurs formules sont variables.

La deuxième comprend tous ceux qui s'altèrent à 100° sous l'influence des alcalis, qui reduisent le tartrate cupro-potassique, qui fermentent directement, que l'acide sulfurique concentré ne charbonne pas immédiatement à froid, et qui ont pour formule $C^6H^{12}O^6$ (1).

Dans la troisième sont rangés des principes sucrés qui ne fermentent point sous l'influence de la levûre de bière, qui n'ont pas tous des propriétés semblables et qui sont isomères des sucres de la deuxième classe.

La quatrième, enfin, contient les sucres qui ne fermentent pas par eux-mêmes, mais qui, par l'action des acides étendus, ou même des ferments, se transforment en sucres directement fermentescibles. Ces sucres ne réduisent pas le tartrate cupro-potassique, ne sont pas altérés par les alcalis; à 100°, l'acide sulfurique concentré les charbonne à froid; et, convenablement desséchés, ils répondent à la formule $C^{12}H^{22}O^{11}$. Entre les sucres de cette classe et ceux de la deuxième se trouve un corps qui paraît établir la transition, la lactose : ce sucre appartient à la deuxième classe par ses propriétés, et à la quatrième par sa formule, lorsqu'il a été desséché à 150°.

Dans la première classe, nous trouvons :

A. Des sucres dont la formule est $C^6H^{14}O^6$: ce sont la mannite et la dulcite.

B. Des sucres dont la formule est $C^6H^{12}O^5$: ce sont la pinite et la quercite.

C. Un sucre qui a pour formule $C^4H^{10}O^4$: c'est l'érythrite.

Dans la deuxième classe, nous rencontrons : la glucose, la maltose, la lévulose, la galactose et la mannitose.

(1) $H=1$, $C=12$, $O=16$.

Dans la troisième, se trouvent l'inosite, la sorbine et l'eucalyne.

Dans la quatrième classe, enfin, nous placerons le sucre de canne ou saccharose, la mélitose, la mélézitose, la tréhalose, le mycose, la parasaccharose, et la lactose, qui, ainsi que nous l'avons dit, forme la transition entre les sucres de cette classe et les congénères de la glucose.

En dernier lieu, nous placerons deux sucres mal connus, que nous ne citons que pour mémoire : l'indiglucite et l'évonymite, de M. W. Kubel (1).

L'objet de notre travail étant bien établi, il nous reste à en exposer le plan.

En premier lieu, nous ferons l'étude individuelle des sucres de la première classe; nous étudierons ensuite de la même manière, et successivement, les sucres des trois autres classes.

Puis, tirant des conclusions générales des faits que nous aurons passés en revue, nous parlerons de la fonction des sucres et de quelques principes neutres qui s'y rapportent.

Enfin nous nous occuperons des applications que les sucres ont reçues en pharmacie, et de la saccharimétrie.

(1) *Journal für praktische Chemie*, t. LXXXV, 1863, p. 372, n° 6.

CHAPITRE PREMIER.

ÉTUDE INDIVIDUELLE DES SUCRES DE LA PREMIÈRE CLASSE.

Groupe A. — Sucres à formule $C^6H^{14}O^6$.

MANNITE. $C^6H^{14}O^6$.

La mannite a été découverte par Proust, et c'est Liebig qui en a déterminé la composition. Sa formule est $C^6H^{14}O^6$. Elle existe dans un grand nombre de substances végétales et dans les jus sucrés qui ont subi la fermentation visqueuse ou la fermentation lactique; on l'extrait généralement de la manne, en épuisant cette substance par l'alcool ordinaire, bouillant, filtrant à chaud et laissant cristalliser; il est bon de purifier la mannite par plusieurs cristallisations successives.

Tout récemment M. Linnemann (1) est parvenu à préparer la mannite au moyen du sucre interverti. A cet effet, il intervertit une certaine quantité de sucre de canne par l'acide sulfurique, sature ensuite la liqueur par un léger excès d'alcali, et ajoute au liquide de l'amalgame de sodium. La réaction développe assez de chaleur pour qu'il soit nécessaire de refroidir: lorsqu'elle paraît terminée, on sature par l'acide sulfurique, on évapore à sec, et l'on extrait la mannite du résidu au moyen de l'alcool, comme s'il s'agissait de l'extraire de la manne.

La mannite est une substance solide, fusible entre 160° et 165°, et pouvant, une fois fondue, rester liquide jusqu'à 140°. La mannite est inactive sur la lumière polarisée; elle se dissout à 18° dans six fois et demie son

(1) *Annalen der Chemie und Pharmacie*, t. CXXIII, p. 136 (nouvelle série, t. XLVII), juillet 1862.

poids d'eau; à froid elle exige 80 d'alcool à 0,89 pour se dissoudre; elle se dissout beaucoup mieux à l'ébullition dans ce véhicule. L'alcool absolu n'en dissout qu'un quatorze centième de son poids, l'éther ne la dissout pas du tout.

La mannite se dépose de sa solution alcolique en cristaux prismatiques quadrilatères, minces, incolores et soyeux.

Sa solution aqueuse, mêlée au sulfate de cuivre, empêche la précipitation de ce dernier par la potasse. La liqueur alcaline portée à l'ébullition ne laisse pas déposer d'oxydule de cuivre. La liqueur de Fehling résiste également à l'action de la mannite.

Si l'on maintient la mannite à une température de 200° environ, une ébullition se manifeste; la plus grande partie de ce sucre reste à peu près inaltérée et à peine colorée; une autre partie se déshydrate et se transforme en mannitane selon l'équation :

$$\underbrace{C^6H^{14}O^6}_{\text{Mannite.}} = H^2O + \underbrace{C^6H^{12}O^5}_{\text{Mannitane.}}$$

Au-dessus de 300°, la mannite se détruit en laissant un charbon poreux. Si, au lieu de la calciner seule, on la mélange à huit fois son poids de chaux, on obtient de la métacétone. Si on la calcine avec de la potasse, il se forme des formiate, acétate et propionate de potasse.

La mannite n'est charbonnée ni à froid ni à chaud par l'acide sulfurique. Si l'on sature par le carbonate de baryte le produit qui résulte de cette réaction, on obtient en dissolution un sel de l'acide sulfomannitique. Cet acide répond à la formule :

$$\left.\begin{matrix} C^6H^{8''} \\ (SO^2)^2 \\ H^4 \end{matrix}\right\} O^7$$

A 100°, la mannite n'absorbe pas l'acide chlorhydrique gazeux, mais elle s'y combine en éliminant de l'eau, et donne naissance à un composé neutre, si l'acide est en solution aqueuse concentrée. Avec les acides acétique, butyrique, valérique, benzoïque, etc., et à une température de 250°, il se produit des combinaisons neutres analogues aux éthers composés et aux corps gras, que M. Berthelot désigne sous le nom de *mannitanides*. Pour isoler ces combinaisons, on sature l'excès d'acide par un alcali, et l'on traite par l'éther, qui dissout le composé formé. L'acide tartrique forme avec la mannite un acide qui a reçu le nom d'*acide manni-tartrique*, et qui répond à la formule :

$$\left.\begin{matrix} C^6H^{8^{VI}} \\ 6(C^4H^4O^6) \\ H^6 \end{matrix}\right\} O^{12}.$$

Avec l'acide azotique monohydraté, on obtient de la mannite hexanitrique :

$$\left.\begin{matrix} C^6H^{8^{VI}} \\ 6(AzO^2) \end{matrix}\right\} O^6.$$

Enfin l'acide oxalique se décompose par la seule présence de la mannite en acide formique et en acide carbonique, exactement comme avec la glycérine.

En chauffant au bain-marie, pendant environ quarante heures, un mélange de mannite et de potasse en solution aqueuse concentrée, reprenant ensuite par l'éther et faisant évaporer ce liquide, on obtient l'éthyl-mannite $C^{10}H^{20}O^5$, que l'on peut écrire $\left.\begin{matrix} C^6H^{8^{VI}} \\ (C^2H^5)^2 \\ H^2 \end{matrix}\right\} O^5$, en la dérivant de la mannitane $\left.\begin{matrix} C^6H^{8^{VI}} \\ H^4 \end{matrix}\right\} O^5$.

Les bases se combinent facilement avec la mannite. On obtient ces combinaisons en dissolvant la base dans une solution de mannite et précipitant par l'alcool (1). On connaît deux composés calciques qui ont pour formule : CaO, $C^6H^{14}O^6 + 2\,aq$ (2) et CaO, $(C^6H^{14}O^6)^2$; la baryte n'a fourni

(1) Ubaldini, *Annales de physique et de chimie*, 3e série, t. LVII, p. 213.
(2) Ca = 40.

qu'un seul composé dont la formule est $(BaO)^2, C^6H^{14}O^6$ (1); avec la strontiane on n'a obtenu également qu'une seule combinaison qui a pour formule $StO, C^6H^{14}O^6$ (2). Enfin l'acétate de plomb ammoniacal précipite la mannite et le précipité a pour formule $C^6H^{10}Pb^2O^6$ (3). Lorsqu'on soumet la mannite à des actions oxydantes, les effets varient selon l'énergie des moyens employés, si ceux-ci sont très-énergiques, il se produit de l'acide oxalique : s'ils le sont moins, comme cela a lieu avec l'acide azotique fort étendu, il se produit un acide qui paraît identique avec l'acide saccharique, et si l'on fait agir le noir de platine sur une solution concentrée de mannite, on donne naissance à un acide qui a reçu le nom d'*acide mannitique* (4), ainsi qu'à un sucre inactif de la famille de la glucose, et qu'on a nommé *mannitose*. L'acide mannitique dérive de la mannite par une réaction analogue à celle d'après laquelle les acides acétique, glycolique et glycérique dérivent respectivement de l'alcool, du glycol et de la glycérine.

$$\underbrace{\left.\begin{matrix} C^2H^5 \\ H \end{matrix}\right\}}_{\text{Alcool.}} O + O^2 = \left.\begin{matrix} H \\ H \end{matrix}\right\} O + \underbrace{\left.\begin{matrix} C^2H^3O \\ H \end{matrix}\right\}}_{\text{Acide acétique.}} O.$$

$$\underbrace{\left.\begin{matrix} C^2H^{4''} \\ H^2 \end{matrix}\right\}}_{\text{Glycol.}} O^2 + O^2 = \left.\begin{matrix} H \\ H \end{matrix}\right\} O + \underbrace{\left.\begin{matrix} C^2H^2O'' \\ H^2 \end{matrix}\right\}}_{\text{Acide glycolique.}} O^2.$$

$$\underbrace{\left.\begin{matrix} C^3H^{5'''} \\ H^3 \end{matrix}\right\}}_{\text{Glycérine.}} O^3 + O^2 = \left.\begin{matrix} H \\ H \end{matrix}\right\} O + \underbrace{\left.\begin{matrix} C^3H^3O''' \\ H^3 \end{matrix}\right\}}_{\text{Acide glycérique.}} O^3.$$

$$\underbrace{\left.\begin{matrix} C^6H^{8^{VI}} \\ H^6 \end{matrix}\right\}}_{\text{Mannite.}} O^6 + O^2 = \left.\begin{matrix} H \\ H \end{matrix}\right\} O + \underbrace{\left.\begin{matrix} C^6H^6O^{VI} \\ H^6 \end{matrix}\right\}}_{\text{Acide mannitique.}} O^6.$$

(1) Ba = 127.
(2) St = 88.
(3) Pb = 208.
(4) Gorup Besanez, *Annales de chimie et de physique*, 3e série, t. LXII, p. 489.

Distillée dans un courant d'acide carbonique en présence d'une solution très-concentrée d'acide iodhydrique, la mannite se transforme en iodure d'héxyle $C^6H^{13}I$ (1) d'après l'équation

$$C^6H^{14}O^6 + 11 \left.\begin{matrix} H \\ I \end{matrix}\right\} = 6 \left.\begin{matrix} H \\ H \end{matrix}\right\} O + \underbrace{\left.\begin{matrix} C^6H^{13} \\ I \end{matrix}\right\}}_{\text{Iodure d'hexyle.}} + 10 I.$$

Cette réaction tout à fait identique avec celle qui transforme la glycérine en iodure de propyle, fixe définitivement la formule de la mannite et rend inacceptable la formule $C^6H^7O^6$ que donnaient certains chimistes en faisant $C = 6, O = 8$, et $H = 1$.

En présence de la levûre de bière, la mannite ne fermente pas; si l'on maintient sa solution à 40°, après l'avoir mêlée avec de la craie et du fromage blanc, du tissu pancréatique ou de l'albumine, la fermentation a lieu ; il se dégage de l'hydrogène et de l'acide carbonique, et il se produit de l'alcool, ainsi que des acides lactique et butyrique. Ces deux acides paraissent être le résultat d'une fermentation concomitante, mais différente de celle qui fournit l'alcool. M. Berthelot affirme que, dans cette dernière, il ne se développe aucun globule de levûre.

MANNITANE. $C^6H^{12}O^5$.

La mannitane, ou premier anhydride de la mannite, peut, suivant M. Berthelot (2), s'obtenir par trois procédés, qui sont : 1° la saponification des éthers mannitiques ; 2° l'action d'une température de 200° sur la mannite ; 3° l'action d'une température de 100° sur la mannite maintenue en contact avec l'acide chlorhydrique.

Pour saponifier les éthers mannitiques, on peut, soit les

(1) Wanklyn et Erlenmeyer, *Annales de chimie et de physique*, 3e série, t. LXV, p. 364.

(2) Berthelot, *Annales de chimie et de physique*, 3e série, t. XLVII, p. 297.

chauffer avec l'eau à 240°, soit les chauffer à 100°, avec une solution alcaline, soit enfin dissoudre la combinaison que l'on désire saponifier dans l'alcool additionné d'acide chlorhydrique. Dans ce cas, l'alcool s'empare de l'acide de l'éther mannitique et la mannitane devient libre.

Quel que soit le procédé que l'on mette en usage pour la préparer, la mannitane doit être purifiée par plusieurs dissolutions successives dans l'alcool absolu qui la dissout seule.

La mannitane a pour formule $C^6H^{12}O^5$; elle est liquide et sirupeuse ; à 140°, elle émet quelques vapeurs ; au contact de l'air, elle absorbe l'humidité et finit par régénérer des cristaux de mannite ; cette régénération s'opère bien plus rapidement si l'on chauffe la mannitane dans un tube scellé avec de l'eau de baryte.

La mannitane chauffée dans des tubes scellés avec des acides régénère les mêmes combinaisons neutres que la mannite.

En s'appuyant sur ces deux faits, que les mannitanides produisent de la mannitane lorsqu'on les saponifie, et qu'ils se régénèrent au moyen de la mannitane et des acides, M. Berthelot conclut que ce n'est point la mannite, mais bien la mannitane qui est un alcool, et que la mannite n'est qu'un hydrate de cet alcool. Il se base en second lieu sur le nombre de mannitanides qu'un même acide monobasique peut fournir avec la mannitane. Pour considérer ce corps comme un alcool hexa-atomique, nous aurons à revenir plus loin sur cette question.

MANNIDE. $C^6H^{10}O^4$.

Le mannide, ou second anhydride de la mannite, a été obtenu par M. Berthelot comme produit secondaire, dans la préparation de la mannite butyrique.

C'est une substance sirupeuse un peu sucrée, puis amère, soluble dans l'eau et l'alcool.

Le mannide fournit de la mannite dans les mêmes conditions que la mannitane : chauffé avec de l'acide benzoïque, il donne naissance à un composé neutre, soluble dans l'éther, qui paraît être la mannite benzoïque. On n'a pas pu pousser la déshydratation de la mannite au delà du mannide.

DULCITE. $C^6H^{14}O^6$.
(Synonymie : *Dulcose, dulcine.*)

En 1848, il arriva de Madagascar une substance en petits rognons recouverts de cristaux et dont l'origine botanique est inconnue. De cette substance, Laurent put extraire la dulcite par un procédé fort simple, puisqu'il suffisait de l'épuiser par l'eau bouillante, de filtrer et d'abandonner la liqueur filtrée au refroidissement.

Depuis lors, M. Eichler a donné un procédé pour retirer du *Melampyrum nemorosum* une substance qu'il a nommée mélampyrine, et que M. Gilmer a démontrée être identique avec la dulcite de Laurent.

Pour extraire la dulcite du *Melampyrum nemorosum*, on fait une décoction de cette herbe ; on y ajoute assez de chaux pour rendre la liqueur alcaline, et l'on concentre. Arrivé à un degré de concentration assez avancé, on sature la chaux par l'acide chlorhydrique, et même on ajoute un léger excès de cet acide ; on évapore encore un peu, et, en laissant refroidir, on obtient la dulcite en cristaux très-blancs.

La dulcite présente une saveur sucrée analogue à celle de la mannite ; elle se dissout bien dans l'eau, difficilement dans l'alcool ; son point de fusion est situé à 182° ; à 275°, elle se détruit en se charbonnant.

La dulcite cristallise en prismes rhomboédriques obliques ; elle n'a aucun pouvoir rotatoire ; les alcalis bouillants ne l'altèrent pas ; les acides se comportent avec elle comme avec la mannite. Traitée par l'acide azotique, elle se convertit en acide oxalique et en acide mucique. D'après

M. Carlet, il se produit en outre une certaine quantité d'acide paratartrique (1).

Ce dernier fait semble indiquer qu'elle n'est inactive sur la lumière polarisée que par compensation. Avec la chaux et la baryte, elle donne des combinaisons analogues à celles que fournit la mannite dans les mêmes circonstances ; elle est également précipitée par l'acétate de plomb ammoniacal.

En présence de la levûre de bière, la dulcite ne fermente pas. Si on la mêle avec de la craie, du fromage blanc et de l'eau, et si l'on abandonne le tout à 40°, il se produit de l'hydrogène, de l'acide carbonique, de l'alcool, de l'acide butyrique et de l'acide lactique.

Sous l'influence de la chaleur, la dulcite peut perdre une molécule d'eau, et donner la dulcitane, que l'on isole en la dissolvant dans l'alcool ; d'ailleurs la dulcitane peut s'obtenir de la dulcite par tous les procédés qui permettent d'obtenir la mannitane de la mannite. La formule de la dulcitane est $C^6H^{12}O^5$.

Abandonnée à l'air libre, la dulcitane, qui est sirupeuse, se transforme en cristaux de dulcite. Chauffée avec les acides, elle s'y combine et donne les mêmes composés neutres que la dulcite (dulcitanides).

En somme, la dulcite diffère de la mannite par sa forme cristalline, par son point de fusion situé à 182° et non à 165°, et par sa propriété de donner de l'acide mucique lorsqu'on l'oxyde. L'isomérie de la mannite et de la dulcite se continue dans les dérivés de ces deux corps.

(1) Carlet, *Comptes rendus de l'Académie des sciences*, t. LI, p. 137.

Groupe B. — Sucres à formule $C^6H^{12}O^5$.

PINITE. $C^6H^{12}O^5$.

M. Berthelot extrait la pinite de concrétions qui se rencontrent sur le *Pinus Lambertiana*. Ces concrétions, traitées par l'eau tiède, fournissent une liqueur qu'on décolore par le charbon animal et qu'on abandonne ensuite à l'évaporation spontanée. La liqueur devient sirupeuse, et, après un temps fort long, il s'y développe des cristaux de pinite qu'on purifie en les dissolvant dans l'eau froide et en soumettant leurs solutions à l'évaporation spontanée. Deux ou trois cristallisations fournissent la pinite très-pure.

La pinite a une saveur presque aussi sucrée que le sucre de canne; elle se présente en petits cristaux, courts et groupés en mamelons, qu'il n'a pas été possible de déterminer.

Elle est très-soluble dans l'eau, insoluble dans le chloroforme; l'alcool étendu la dissout un peu, mais l'alcool absolu ne la dissout pas sensiblement; sa densité est égale à 1,52.

La solution aqueuse de la pinite dévie à droite le plan de polarisation de la lumière; son pouvoir rotatoire moléculaire déterminé à 60° est égal à 58°,86. A 100°, l'acide chlorhydrique fumant n'avait pas modifié ce pouvoir rotatoire après cinq minutes.

A 150°, la pinite ne fond pas; au-dessus de 250° elle fond, se boursoufle et laisse un résidu de charbon. Dans le vide elle résiste sans se décomposer et sans se volatiliser sensiblement à l'action d'une température voisine du point d'ébullition du mercure.

Les alcalis n'altèrent pas la pinite à 100°, et le tartrate cupro-potassique n'est point réduit par ce corps.

La pinite réduit la solution de l'azotate d'argent.

L'acide sulfurique forme avec la pinite à chaud un acide pinisulfurique dont le sel de chaux est soluble, mais se décompose pendant l'évaporation. Si l'on chauffait sans précau-

tion le mélange de pinite et d'acide sulfurique, ce mélange noircirait en se carbonisant.

L'action de l'acide azotique sur la pinite paraît donner des dérivés nitrés en même temps qu'elle fournit de l'acide oxalique.

Les acides acétique, benzoïque, etc., chauffés à 150° avec la pinite, forment des composés neutres qui régénèrent la pinite lorsqu'on les saponifie; ces corps neutres ont reçu le nom de *pinitides*.

La pinite ne subit pas la fermentation alcoolique en présence de la levûre de bière.

La pinite est isomérique avec la mannitane et la dulcitane qui, comme elle, se combinent aux acides pour former les mannitanides et les dulcitanides; mais elle diffère essentiellement de ces deux corps : 1° en ce qu'elle est cristallisée et douée de pouvoir rotatoire, tandis que la mannitane et la dulcitane sont sirupeuses et inactives; 2° en ce qu'elle n'est pas soluble dans l'alcool qui dissout fort bien la mannitane et la dulcitane; 3° en ce qu'abandonnée à l'humidité elle ne s'hydrate pas. Ces dissemblances dans les propriétés nous semblent correspondre à des différences dans les fonctions de ces corps, comme nous le verrons plus tard.

QUERCITE. $C^6H^{12}O^5$.

La quercite s'extrait du gland de chêne par le procédé suivant que nous devons à M. Dessaignes (1). On écrase les glands et on les fait macérer avec de l'eau, puis on filtre; la liqueur s'éclaircit au bout de quelques heures en laissant se déposer de l'amidon. Quand elle est tout à fait claire, on la traite par la chaux afin de précipiter le tannin et une petite quantité de matière azotée; on évapore ensuite et on abandonne les liqueurs au refroidissement. La quercite se dépose

(1) *Comptes rendus de l'Académie des sciences*, t. XXXIII, 1851, p. 308, 462.

en cristaux qu'on lave avec de l'alcool affaibli, et qu'on purifie par une nouvelle cristallisation dans l'eau.

La quercite se dissout bien dans l'eau ; elle peut cristalliser de cette dissolution sans que celle-ci devienne sirupeuse; elle est à peu près insoluble dans l'alcool absolu ; sa solution aqueuse dévie à droite le plan de polarisation de la lumière. Le pouvoir rotatoire moléculaire de la quercite est égal à $+ 35°,5$.

La quercite cristallise en beaux prismes rhomboïdaux obliques, inaltérables à l'air, durs et croquants sous la dent. Ces cristaux fondent à 235° et répandent alors des vapeurs sensibles. A 300°, ce corps se détruit complétement en laissant un résidu de charbon. La solution aqueuse de la quercite ne fermente pas par la levûre de bière, même après avoir subi l'action de l'acide chlorhydrique à 100°. Elle ne s'altère pas non plus lorsqu'on la mêle avec du fromage.

Lorsqu'on oxyde la quercite par l'acide azotique, on obtient de l'acide oxalique et jamais de l'acide mucique.

Avec l'acide sulfurique, même à chaud, cette substance ne noircit pas. Les deux corps se combinent et il se forme un acide copulé dont le sel de chaux est incristallisable.

En soumettant la quercite à l'action d'un mélange d'acide azotique et d'acide sulfurique, on obtient un produit nitré qui régénère de la quercite lorsqu'on le traite par le sulfhydrate d'ammoniaque.

Les alcalis puissants n'altèrent pas la quercite à la température de l'ébullition, et le tartrate cupro-potassique n'est pas réduit.

La solution de la quercite dissout un peu la chaux et mieux la baryte. Si l'on évapore dans le vide, il reste un corps dont l'analyse répond assez bien à la formule $Bao,(C^6H^{12}O^5)^2 + 2aq$.

L'acétate de plomb ammoniacal donne un précipité avec les solutions de quercite. A 250°, la quercite se combine

aux acides benzoïque, stéarique, etc., en donnant des corps neutres analogues aux mannitanides et aux corps gras. Sous l'influence de l'eau ou des alcalis et de la chaleur, ces corps se saponifient.

La quercite est isomérique avec la mannitane et la dulcitane, dont elle diffère par son insolubilité dans l'alcool, son pouvoir rotatoire et sa faculté de cristalliser. Quant à la pinite, elle en diffère seulement par sa forme cristalline et son pouvoir rotatoire.

Groupe C. — Sucre à formule $C^4H^{10}O^4$.

ÉRYTHRITE. $C^4H^{10}O^4$.

L'érythrite a été obtenue, d'abord, par la métamorphose d'un principe contenu dans le *Rocella Montagnei*. Depuis, M. Lamy (1) l'a trouvée dans le *Protococcus vulgaris*, et lui a donné le nom de *phycite ;* mais celui d'*érythrite* lui est resté.

Pour extraire l'érythrite du *Protococcus vulgaris*, on fait une décoction de la plante, qu'on évapore à consistance sirupeuse, et qu'on traite ensuite par l'alcool, pour précipiter la gomme. On filtre, et la liqueur filtrée, soumise à une évaporation lente, laisse alors déposer des cristaux d'érythrite. M. de Luynes (2), qui s'est occupé tout récemment de l'érythrite, préfère avoir recours à la décomposition de l'acide érythrique par les alcalis. Il introduit l'acide érythrique humide dans une chaudière de tôle, avec de la chaux éteinte, et chauffe à 150° pendant deux heures environ ; il filtre ensuite pour séparer une certaine quantité de carbonate de chaux qui s'est formée, évapore un peu la liqueur et laisse refroidir ; il se dépose alors de l'orcine, que l'on sépare. Les eaux mères sont ensuite évaporées à siccité, et le résidu est

(1) *Annales de chimie et de physique*, 3e série, 1857, t. LI, p. 232.

(2) De Luynes, *Comptes rendus de l'Académie des sciences*, t. LVI, p. 803.

traité par l'éther, qui enlève le reste de l'orcine et laisse l'érythrite pure.

L'érythrite cristallise en prismes à base carrée. Elle est soluble dans l'eau, et donne avec ce liquide une solution qui devient sirupeuse avant de cristalliser. L'alcool bouillant la dissout ; mais l'éther ne la dissout pas.

L'érythrite est inactive, et sa densité est égale à 1,59. Elle fond à 120°, résiste à une température de 250°, et se détruit en partie vers 300°. Elle présente à un haut degré le caractère de la surfusion.

Les solutions d'érythrite dissolvent la chaux, ne sont pas précipitées par l'acétate de plomb ammoniacal, et ne réduisent pas la liqueur de Fehling, même après avoir subi l'action des acides dilués à la température de l'ébullition.

Chauffée à 240° avec de la potasse, l'érythrite produit un dégagement d'hydrogène, et l'on trouve de l'oxalate de potasse dans le résidu.

Sa solution aqueuse s'oxyde sous l'influence du noir de platine, en donnant un acide non encore complétement étudié ; avec l'acide azotique, il se produit aussi une oxydation, mais l'on n'obtient que de l'acide oxalique.

Si l'on distille l'érythrite avec une solution concentrée d'acide iodhydrique, on obtient de l'iodure de butyle C^4H^9I, selon l'équation suivante :

$$C^4H^{10}O^4 + 7HI = 4\left.\begin{matrix}H\\H\end{matrix}\right\} O + \left.\begin{matrix}C^4H^9\\I\end{matrix}\right\} + 6I.$$

Cette dernière réaction, découverte par M. de Luynes (1), est très-importante, en ce qu'elle fixe définitivement la formule de l'érythrite.

L'érythrite, chauffée à 250° avec les acides stéarique et benzoïque, s'y combine à la manière de la mannite. Elle se combine aussi à l'acide tartrique à 100°, et à l'acide sulfurique à froid.

(1) *Comptes rendus de l'Académie des sciences*, t. LV, p. 624.

L'acide chlorydrique, même bouillant, ne la carbonise pas.

M. Berthelot considère l'érythrite comme une substance intermédiaire entre la mannite et la glycérine. Cette manière de voir est parfaitement justifiée depuis que M. de Luynes a donné pour l'érythrite la formule $C^4H^{10}O^4$. Cette formule démontre en effet que l'érythrite est un alcool tétratomique intermédiaire, par conséquent, entre la mannite, qui est hexa-atomique, et la glycérine qui n'est que triatomique.

M. Berthelot a donné le nom d'érythrides aux combinaisons de l'érythrite avec les acides.

L'érythrine, ou acide érythrique, que l'on rencontre dans la plupart des lichens, est un érythride de l'acide orsellique.

CHAPITRE II

SUCRES QUI RÉPONDENT A LA FORMULE $C^6H^{12}O^6$. — GLUCOSE $C^6H^{12}O^6 + aq.$

La glucose est extrêmement répandue. On la rencontre pure dans l'urine des diabétiques, et dans le miel et le sucre interverti à l'état de mélange avec la lévulose. On peut l'obtenir par le dédoublement de certains principes organiques, tels que la salicine et l'arbutine, ou par l'action des acides étendus ou de la diastase sur l'amidon. La cellulose peut également se transformer en glucose sous l'influence des acides.

La gélatine traitée par l'acide sulfurique étendu et bouillant (1), et la chondrine soumise à l'action de l'acide chlorhydrique concentré et bouillant (2), donnent également un sucre de la famille des glucoses, mais on ignore encore si ces sucres sont identiques avec la glucose elle-même.

On peut extraire la glucose soit du miel ou du sucre interverti, soit de l'urine des diabétiques, soit enfin, et c'est là le procédé le plus usité, la préparer au moyen de l'amidon.

Lorsque le miel ou le sucre interverti sont abandonnés à eux-mêmes, pendant un certain temps la glucose s'y dépose en cristaux. Si l'on traite alors la masse par de l'alcool froid, celui-ci enlève la lévulose qui surnage, et la glucose reste à peu près pure.

Pour extraire la glucose de l'urine des diabétiques, on concentre le liquide au point d'amener la cristallisation de ce sucre. On lave les cristaux à l'alcool froid, puis on les

(1) Gerhardt, *Traité de chimie organique*, t. IV, p. 509.

(2) Fischer et Boedeker, *Annalen der Chemie und Pharmacie*, t. CXVII, p. 111 (nouv. sér., t. XLI), janvier 1861.

redissout dans l'eau et on les soumet à une nouvelle cristallisation. Enfin dans les cas de beaucoup les plus fréquents, toutes les fois qu'on a pour but non point d'extraire la glucose pour la reconnaître et l'analyser, mais bien de préparer ce corps, on a recours à l'action que les acides ou la diastase exercent sur l'amidon.

Veut-on faire usage de la diastase, on chauffe à 70° un mélange d'eau d'amidon et d'orge germée jusqu'à ce que la liqueur ne bleuisse plus par l'iode, puis on filtre et l'on évapore jusqu'à consistance sirupeuse. La glucose cristallise au bout de quelque temps.

Lorsqu'on veut faire usage des acides, on fait un mélange d'amidon et d'acide sulfurique ou chlorhydrique étendu, et l'on chauffe au moyen d'un courant de vapeur jusqu'à ce que la liqueur ne bleuisse plus par l'iode et ne précipite plus par l'alcool. Lorsqu'on a atteint ce premier résultat, on sature le liquide par le carbonate de chaux, puis on le filtre, on l'évapore jusqu'à consistance sirupeuse et on l'abandonne à la cristallisation.

On peut substituer la cellulose à l'amidon ; pour cela il faut d'abord dissoudre la cellulose dans l'acide sulfurique concentré, puis étendre d'eau, saturer une partie de l'acide, et achever l'opération en chauffant pendant une douzaine d'heures à 100°.

La transformation de l'amidon en glucose mérite de fixer notre attention. Longtemps on a cru que c'était là un fait de simple hydratation ; on pensait que l'amidon $C^6H^{10}O^5$ se transforme en dextrine par une simple modification isomérique, et que la dextrine absorbe ensuite une molécule d'eau H^2O pour se transformer en glucose. Mais il résulte d'un travail très-important, publié récemment par M. Musculus (1), qu'en réalité les choses ne se passent point ainsi. La diastase opère

(1) *Annales de chimie et de physique*, t. LX, p. 203, 3e série, et *Comptes rendus de l'Académie des sciences*, t. LIV, p. 194.

le dédoublement de l'amidon en glucose et dextrine, et le phénomène est comparable à la saponification par l'eau des éthers ou des corps gras. Lorsque le dédoublement de l'amidon est complet, la dextrine peut, à son tour, être partiellement saccharifiée. Par la diastase, cette saccharification est toujours incomplète. Avec les acides les phénomènes sont identiques, avec cette différence que la saccharification de la dextrine formée d'abord est beaucoup plus facile.

La glucose est très-soluble dans l'eau, quoiqu'elle s'y dissolve avec moins de facilité que le sucre de canne. Une partie de glucose exige une partie et tiers d'eau froide pour se dissoudre; elle est également soluble dans l'alcool ordinaire bouillant, moins bien dans l'alcool froid.

Lorsqu'on évapore une solution aqueuse de glucose, elle prend l'état sirupeux avant de cristalliser, et ce n'est qu'après un repos assez long que les cristaux se déposent.

Cristallisée, la glucose se présente sous la forme de mamelons, de choux-fleurs mal définis. Ces cristaux contiennent une molécule d'eau de cristallisation qu'ils perdent à 70° ou à 80° après avoir subi la fusion ignée.

La glucose est dextrogyre, son pouvoir rotatoire moléculaire est égal à + 56°.

La glucose sèche peut être portée jusqu'à la température de 120° ou même de 130° sans s'altérer. A 140°, elle perd de l'eau et se transforme en caramel. Si l'on continue à chauffer, elle donne les mêmes produits de décomposition que le sucre de canne.

Si l'on fait bouillir pendant longtemps la glucose avec des acides sulfurique ou chlorhydrique étendus, elle s'altère en donnant des composés acides et ulmiques dont nous avons déjà parlé. Lorsque cette décomposition s'opère au contact de l'air, il se produit en outre de l'acide formique.

L'acide sulfurique concentré et froid transforme la glucose en un acide copulé sans la charbonner.

Les bases alcalines ou alcalino-terreuses se combinent

facilement avec ce sucre, mais ces combinaisons sont très-instables et se détruisent à la température de l'ébullition. On les obtient en dissolvant dans la solution glucosique la base dont on désire obtenir le glucosate, puis on précipite par l'alcool. On a pu obtenir ainsi : le glucosate de baryte $(C^6H^{12}O^6)^2(BaO)^3 + 2$ aq, et le glucosate de chaux $(C^6H^{12}O^6)^2(CaO)^3 + 2$ aq.

L'oxyde de plomb donne avec la glucose un composé qui répond à la formule :

$$\left.\begin{array}{c} C^6H^{6\,VI} \\ C^6H^{6\,VI} \\ Pb^3 \\ H^6 \end{array}\right\} O^{12}.$$

La solution de la glucose réduit à chaud le tartrate cupro-potassique, et à froid le mélange de potasse et de sulfate de cuivre.

La glucose se combine avec le chlorure de sodium ; il se produit un composé cristallisé dont la formule est $(C^6H^{12}O^6)^2$ NaCl + aq.

Lorsqu'on fait bouillir la glucose avec du bioxyde de plomb, on observe un dégagement d'acide carbonique, tandis qu'il se produit du formiate et du carbonate de plomb.

Le chlorure et les perchlorures détruisent la glucose en la charbonnant.

Enfin, les acides butyrique, acétique, stéarique, benzoïque, chauffés pendant cinquante ou soixante heures entre 100° et 120° avec la glucose, s'y combinent en éliminant de l'eau, et donnent des corps neutres analogues aux corps gras et aux mannitanides : ce sont les glucosides de M. Berthelot.

LÉVULOSE. $C^6H^{12}O^6$.

La lévulose se trouve mêlée à la glucose dans le sucre de canne interverti, le miel et le sucre des fruits acides ; on peut l'extraire de ces mélanges par un procédé fort simple que nous devons à M. Dubrunfaut (1). Il consiste à dissoudre 10 grammes de sucre de canne interverti dans 100 grammes d'eau, et à ajouter à la solution 6 grammes de chaux éteinte. Au bout de quelque temps, le tout se prend en une bouillie épaisse qu'on exprime avec une bonne presse. La partie solide est le sel calcaire de la lévulose. La totalité de la glucose reste en solution. Ce sel calcaire, délayé dans l'eau et décomposé par un courant d'acide carbonique, fournit la lévulose pure; il ne reste qu'à filtrer la solution et à l'évaporer.

On obtient plus rapidement la lévulose à l'état de pureté en saccharifiant, par les acides étendus, l'inuline, principe isomérique avec l'amidon, que renferment les racines d'aunée, de dalhia, de colchique et de topinambour.

La lévulose est sirupeuse, déliquescente et incristallisable. Elle se dissout avec la plus grande facilité dans l'eau et l'alcool ordinaire, plus difficilement dans l'alcool absolu. Sa saveur est beaucoup plus sucrée que celle de la glucose.

Son pouvoir rotatoire est lévogyre et égal à 106° à 15°, mais il varie beaucoup avec la température; c'est ainsi qu'à 90° il diminue de moitié et devient égal à 53°.

La glucose ayant, au contraire, un pouvoir rotatoire qui ne varie pas avec la température, on doit retrouver les variations du pouvoir rotatoire de la lévulose dans le sucre interverti, qui est un mélange à poids égaux de glucose et de lévulose. Et, en effet, le sucre interverti, dont le pouvoir rotatoire est de 25° à 15°, devient moitié moindre à 52°, s'annule à 90° et change de signe au-dessus de cette température.

Au-dessus de 100°, la lévulose commence à s'altérer en donnant les mêmes produits de décomposition que la glucose; elle forme avec la chaux un composé insoluble dont la formule est : $^2(C^6H^{12}O^6)(CaO)^3$.

(1) *Annales de chemie et de physique*, 3e série, 1847, t. XXI, p. 169.

La lévulose s'altère plus facilement que la glucose sous l'influence des acides ou de la chaleur; mais elle résiste mieux à l'action des ferments ou des alcalis. On a utilisé sa plus grande résistance à l'action des ferments pour la préparer; en effet, si, pendant le cours d'une fermentation on prend de temps à autre le pouvoir rotatoire de la liqueur, on s'aperçoit qu'au bout d'un certain temps la déviation vers la gauche atteint un maximum et diminue ensuite. Si l'on arrête la fermentation à ce dernier moment, on constate que toute la glucose est détruite et que la liqueur ne contient plus que de la lévulose.

MALTOSE. $C^6H^{12}O^6$.

Lorsqu'on a obtenu la glucose par la diastase et l'amidon, le produit a un pouvoir rotatoire de même sens, mais triple de celui de la glucose ordinaire. Par l'action prolongée des acides étendus, la maltose se transforme en ce dernier sucre. Du reste, les différences qui existent entre la glucose et la maltose ne nous paraissent pas suffisantes pour faire de ce dernier sucre une espèce à part. Ce n'est point un isomère, c'est tout au plus un état allotropique de la glucose.

GALACTOSE. $C^6H^{12}O^6$.

Lorsqu'on fait bouillir pendant quelque temps la lactose avec les acides minéraux étendus, ce corps se transforme en un nouveau sucre très-facilement fermentescible, qui a reçu le nom de *galactose*, et qui a pour formule : $C^6H^{12}O^6$.

La galactose présente les réactions générales des glucoses avec les alcalis et le tartrate cupro-potassique.

Elle cristallise plus facilement que la glucose; son pouvoir rotatoire est dextrogyre et égal à $+ 83°,3$; elle est soluble dans l'eau et peu soluble dans l'alcool froid. Son caractère distinctif le plus saillant, c'est que lorsqu'on l'oxyde par l'acide azotique elle fournit de l'acide mucique.

MANNITOSE. $C^6H^{12}O^6$.

Nous avons déjà dit que lorsqu'on oxyde la mannite par le noir de platine, on obtient un mélange d'acide mannitique et d'un sucre directement fermentescible. Pour séparer celui-ci de l'acide mannitique (1), il suffit de saturer par la chaux, de précipiter par l'alcool, d'évaporer la liqueur filtrée et de la précipiter une seconde fois par l'alcool, après l'avoir amenée à consistance sirupeuse; on la filtre de nouveau et on l'évapore à siccité.

La mannitose est sirupeuse et incristallisable.

Elle est tout à fait inactive vis-à-vis de la lumière polarisée, elle présente toutes les réactions des autres glucoses.

A côté des glucoses bien connues, dont nous venons de retracer l'histoire, devraient se ranger certains principes sucrés, tels que la glucose que l'on obtient par le dédoublement du quercitrin, et qui est inactive, et la glucose qui provient de l'action prolongée de l'eau sur la gomme. Mais ces corps ont été jusqu'ici trop mal étudiés pour nous permettre d'en faire une étude détaillée.

Groupe D. — Sucres à formule $C^6H^{12}O^6$ non fermentescibles par la levûre de bière.

EUCALYNE. $C^6H^{12}O^6$.

Lorsqu'on fait fermenter la mélitose, principe sucré que nous étudierons plus loin, on observe, quand la fermentation est terminée, que la liqueur tient en dissolution un sucre particulier non fermentescible que M. Berthelot a désigné sous le nom d'eucalyne (2). Pour avoir ce principe à l'état de pureté, il suffit de concentrer la solution, de la précipiter par quatre à cinq fois son volume d'alcool, de la filtrer et de l'évaporer.

(1) Gorup Besanez, *loc. cit.*
(2) *Annale de chimie et de physique*, 3e série, t. XLVI, p. 72.

Desséchée à 100°, l'eucalyne répond à la formule $C^6H^{12}O^6$. Séchée à froid dans le vide, elle a pour formule $C^6H^{12}O^6$ + aq.

L'eucalyne est dextrogyre; son pouvoir rotatoire moléculaire est égal à + 50° environ. La chaleur commence à l'altérer à 100°; à 200°, l'altération est complète.

L'eucalyne réduit à chaud le tartrate cupro-potassique.

Sous l'influence de l'acide sulfurique concentré ou de l'acide chlorhydrique fumant, elle se transforme à chaud en substances humoïdes.

Enfin, à 100°, la baryte la décompose avec production d'un corps de coloration très-foncée.

SORBINE. $C^6H^{12}O^6$ (1).

Dans du jus de baies de sorbier, qui avait été abandonné à lui-même pendant quatorze mois, il s'était formé plusieurs fois des dépôts et des végétations, puis ce jus s'était éclairci; on l'a filtré et évaporé jusqu'à consistance de sirop épais. Au bout de quelque temps, le liquide a laissé déposer des cristaux qu'on a redissous et décolorés par le noir animal. Ces cristaux constituaient la sorbine.

Ce corps cristallise en jolis octaèdres rectangulaires du système rhombique, durs et croquants sous la dent. Sa densité est de 1,654 à 15° Il est dextrogyre; son pouvoir rotatoire moléculaire est égal à + 46°,9 à 7°; sa saveur est franchement sucrée. L'alcool la dissout à peine; l'eau en dissout le double de son poids. La sorbine ne se dépose en cristaux de cette solution qu'après que celle-ci a pris l'état sirupeux.

Soumise à l'action de la chaleur, la sorbine commence par fondre sans changer de poids; mais si l'on élève la température et que l'on atteigne 180°, elle se décompose et donne naissance à un corps rouge, *l'acide sorbinique.*

(1) Pelouze, *Annales de chimie et de physique*, 3e série, 1852, t. XXXV, p. 222.

Sous l'influence de la levûre de bière, les solutions de sorbine ne fermentent pas ; mais si on les abandonne pendant quelques semaines avec des matières animales et de la craie, on obtient de l'acide lactique et de l'alcool.

Quand on mélange la sorbine avec l'acide sulfurique concentré, la masse se colore, et quand on chauffe elle devient entièrement noire.

L'acide azotique oxyde la sorbine et la transforme en acide oxalique ; enfin l'acide tartrique s'y combine à 100°.

A chaud, les solutions alcalines la jaunissent en l'altérant. L'acétate de plomb ammoniacal la précipite ; la formule du précipité n'est pas bien déterminée.

La sorbine réduit à chaud le tartrate cupro-potassique ; sa solution aqueuse dissout l'hydrate de cuivre, mais au bout d'un certain temps il se dépose de l'oxydule de ce métal. La sorbine se combine avec le chlorure de sodium ; cette combinaison forme de petits cristaux qui, vus au microscope, ont paru cubiques.

INOSITE. $C^6H^{12}O^6 + 2$ aq.

L'inosite existe dans la chair musculaire, le cerveau et le pancréas. Elle a été découverte par M. Vohl (1) dans les haricots verts (*Phaseolus vulgaris*). D'après un travail de M. Gallois, inséré dans les *Comptes rendus de l'Académie des sciences* (2), l'inosite se trouverait encore dans l'urine de quelques diabétiques.

Pour extraire l'inosite des substances animales, M. Lane conseille (3) d'épuiser ces substances préalablement hachées avec de l'eau, de coaguler l'albumine par la chaleur, et de précipiter les liqueurs filtrées par le sous-acétate

(1) *Annalen der Chemie und Pharmacie*, t. XCIX, p. 125 (nouv. sér., t. XXIII, juillet 1856), et même recueil, t. CI, p. 50 (nouv. sér., t. XXVI, janvier 1857).

(2) Tome LVI, p. 533.

(3) *Annalen der Chemie und Pharmacie*, t. CXVII, p. 118 (nouv. sér., t. XLI, janvier 1861).

de plomb. Le précipité plombique est ensuite décomposé par l'hydrogène sulfuré en présence de l'eau ; la liqueur qui résulte de ce traitement est filtrée, concentrée et additionnée de trois ou quatre fois son volume d'alcool. Si le précipité qui se forme adhère au vase, on décante, sinon on filtre. Après vingt-quatre heures, s'il s'est formé des cristaux d'inosite, on les recueille et on les lave à l'alcool froid ; s'il ne s'en est pas formé, on ajoute au liquide une assez forte quantité d'éther, et, après encore vingt-quatre heures de repos, on trouve toute l'inosite cristallisée au fond du vase.

Pour extraire l'inosite des haricots verts, M. Vohl fait une décoction de ces légumes, évapore cette décoction au bain-marie jusqu'à consistance sirupeuse, et y ajoute ensuite assez d'alcool pour produire un précipité persistant ; puis il abandonne ce mélange à lui-même pendant quelques jours ; il se dépose des croûtes que l'on purifie par une nouvelle cristallisation dans l'eau.

L'inosite cristallise en prismes rhomboïdaux efflorescents d'une densité de 1,1154 à 90°.

Très-soluble dans l'eau, elle se dissout difficilement dans l'alcool ordinaire, et elle est tout à fait insoluble dans l'alcool absolu et l'éther. Sa solution n'exerce aucune action sur le plan de polarisation de la lumière.

Chauffée, l'inosite perd d'abord son eau de cristallisation ; au-dessus de 210°, elle fond et peut encore cristalliser ; si l'on continue d'élever la température, elle se boursoufle et se carbonise.

Il est probable qu'à 200° on parviendrait à combiner l'inosite avec les acides gras ou aromatiques : mais l'expérience n'a point été *tentée*. L'inosite résiste à la température de l'ébullition, à l'action de l'acide chlorhydrique et à celle de l'acide sulfurique dilué ; l'acide sulfurique la brunit à 100°.

Le sous-acétate de plomb tribasique précipite l'inosite ; les solutions alcalines bouillantes sont sans action sur ce sucre, qui ne réduit pas non plus le tartrate cupro-potassique.

La levûre de bière ne transforme point l'inosite en alcool, mais ce sucre peut éprouver la fermentation lactique ou butyrique.

Traitée par l'acide azotique mêlé d'acide sulfurique, l'inosite se change en inosite hexanitrique $\left.\begin{matrix} C^6H^{6^{VI}} \\ {}^6(Az\ O^2) \end{matrix}\right\} O^6$.
Ce nouveau corps prend une coloration rosée lorsqu'on l'humecte avec un mélange d'ammoniaque et de chlorure de calcium. On met à profit cette propriété pour reconnaître l'inosite. Pour cela, en effet, on évapore avec précaution un mélange d'inosite et d'acide azotique, et l'on humecte le résidu avec de l'ammoniaque et avec une solution de chlorure de calcium; la coloration rose doit apparaître. Sous l'influence de l'acide azotique bouillant l'inosite finit par se transformer en acide oxalique.

On voit qu'en somme, bien qu'en se rapprochant par sa formule des sucres de la famille des glucoses, comme l'eucalyne et la sorbine, l'inosite est beaucoup plus stable et se rapproche de la mannite par ses propriétés.

CHAPITRE III.

SUCRES DU QUATRIÈME GROUPE, RÉPONDANT A LA FORMULE $C^{12}H^{22}O^{11}$.

SUCRE DE CANNE OU SACCHAROSE. $C^{12}H^{22}O^{11}$.

Le sucre de canne existe dans le jus de la canne à sucre, du sorgho, du maïs, de la betterave, de la carotte, de l'érable. On a cru jusqu'à ces dernières années que les fruits acides n'en contenaient aucune trace, mais M. Buignet (1) a démontré en 1861 : 1° que la plupart des fruits acides contiennent une partie assez considérable de leur matière sucrée à l'état de sucre de canne; 2° que la partie qui n'est pas à l'état de saccharose, est à l'état de sucre interverti, ce qui démontre, puisque le sucre de canne est le seul qui fournisse du sucre interverti, que la matière sucrée a toujours commencé par être de la saccharose; 3° que ce qui produit l'inversion dans les fruits, ce n'est pas l'acide, mais une substance organique qui joue le rôle de ferment; 4° que, selon toutes les probabilités, le sucre se forme au détriment de l'amidon, et d'une substance de la nature des tannins qui existe dans les fruits.

On retire le sucre de canne de la canne à sucre ou de la betterave. Nous décrirons seulement d'une manière générale, les procédés d'extraction qui sont tout industriels, et dont les détails ne sauraient trouver place ici. Pour extraire le sucre de la canne on exprime le suc de cette plante. On le chauffe avec quelques centièmes de chaux (défécation) pour éliminer les substances albuminoïdes qui viennent alors se séparer sous forme d'écume; enfin on évapore et on fait cristalliser.

(1) *Annales de chimie et de physique*, 3e série, t. LXI, p. 233.

Le sucre ainsi obtenu porte le nom de *sucre brut* ou *cassonade;* on le soumet à l'opération du raffinage. Cette opération consiste à dissoudre de nouveau le sucre dans l'eau, à décolorer la dissolution par le noir animal en poudre et le sang de bœuf, et à la faire cristalliser de nouveau après l'avoir filtrée.

La cristallisation s'opère dans des moules coniques. Quand elle est terminée on soumet le pain au clairçage; pour claircer le sucre on fait filtrer du sirop à travers cette substance. Le sirop qui en est saturé ne peut plus en dissoudre, mais dissout les matières étrangères, et le pain de sucre devient parfaitement blanc.

Le procédé qui sert à extraire le sucre de la betterave est identique avec le précédent, avec cette différence, que lorsqu'on a retiré et déféqué le jus, au lieu de l'évaporer immédiatement, on commence par le filtrer sur du noir animal en grains.

Lorsqu'on veut obtenir le sucre en gros cristaux (sucre candi), on abandonne dans une étuve sa solution aqueuse préalablement évaporée au point de marquer 37° à l'aréomètre.

Si l'on cuit le sirop jusqu'à ce qu'en y plongeant le doigt mouillé et le replongeant immédiatement dans l'eau froide, on enlève une couche qui soit fragile après avoir été détachée et roulée, on obtient le sucre d'orge. En aromatisant ce sucre avec diverses essences, on a le sucre de pomme.

Le sucre de canne est soluble en toute proportion dans l'eau bouillante, et fort soluble dans l'eau froide; ses solutions forment un sirop avant de cristalliser; il est insoluble dans l'alcool absolu et l'éther; l'alcool ordinaire bouillant le dissout un peu.

Le sucre de canne cristallise en prismes rhomboïdaux obliques, hémiédriques, durs et anhydres. Il a pour densité 1,606. Il dévie à droite la lumière polarisée, et son pouvoir rotatoire moléculaire est égal à $+73°,8$; il ne varie pas sensiblement avec la température.

Lorsqu'on chauffe le sucre de canne, il fond à 106° sans s'altérer; mais si l'on prolonge l'action de cette température, il se dédouble en glucose et en lévulosane (1).

$$\underbrace{C^{12}H^{22}O^{11}}_{\text{Saccharose.}} = \underbrace{C^{6}H^{12}O^{6}}_{\text{Glucose.}} + \underbrace{C^{6}H^{10}O^{5}}_{\text{Lévulosane.}}$$

On peut extraire ce dernier composé du mélange en détruisant la glucose par la fermentation et évaporant les solutions. Toutefois, on ne l'obtient jamais pure. Chauffée avec les acides étendus, cette lévulosane donne naissance à de la lévulose.

Si l'on porte la saccharose à une température élevée, il se forme des produits qui ont été désignés sous les noms d'*acide caramélique*, de *caramélan*, etc. Ces produits sont noirs, impossibles à purifier, et paraissent être le résultat d'une condensation moléculaire.

Les acides étendus et bouillants changent le pouvoir rotatoire du sucre de canne et le transforment en un mélange de glucose et de lévulose, qui a reçu le nom de *sucre interverti*.

Si l'on prolonge l'action des acides étendus bouillants sur le sucre de canne, et que ces acides soient énergiques, on obtient ces composés humoïdes dont il a été question quand nous nous sommes occupé des sucres en général.

Enfin les acides organiques gras, tels que l'acide acétique, l'acide butyrique, l'acide stéarique, se combinent avec le sucre à 120°, en formant des corps neutres analogues aux corps gras; l'acide tartrique se combine aussi avec la saccharose dans ces conditions. L'acide sulfurique concentré s'échauffe avec le sucre de canne et la masse noircit. En refroidissant, on peut obtenir un acide conjugué.

La saccharose se combine avec la potasse, la baryte, la chaux, etc.

(1) Gelis, *Comptes rendus de l'Académie des sciences*, t. LI, p. 331.

Ces composés résistent très-bien à une température de 100°.

Lorsqu'on dissout la chaux dans de l'eau sucrée, il se produit un composé dont la formule est $C^{12}H^{22}O^{11}$, CaO, et qui est fort soluble. Sous l'influence de la chaleur, la solution de ce corps se coagule et il se précipite un nouveau composé, la saccharose tricalcique, dont la formule est $C^{12}H^{22}O^{11}$, 3(CaO); mais si on laisse refroidir les liqueurs, tout se redissout.

On a également analysé la saccharose barytique $C^{12}H^{22}O^{11}$, BaO, qui est très-peu soluble dans l'eau. Enfin, en précipitant l'eau sucrée par l'acétate de plomb ammoniacal, on obtient un corps qui a pour formule $C^{12}H^{18}Pb^{2}O^{11}$.

Tous ces composés, traités par l'acide carbonique en présence de l'eau, régénèrent la saccharose pure.

Les dissolutions de saccharose ne réduisent pas le tartrate cupro-potassique, néanmoins ce sucre jouit, en présence des alcalis, d'une certaine action réductrice; c'est ainsi qu'il suffit de faire bouillir de l'oxyde d'argent avec un mélange d'eau sucrée et d'une solution alcaline pour obtenir de l'argent métallique.

Le chlore attaque le sucre à la température de 100°; il se forme des composés noirs mal connus. Les perchlorures agissent de la même manière. Si l'on abandonne à la température ordinaire le sucre de canne avec du brome, la masse devient sirupeuse, et la couleur du brome disparaît. Au bout d'un certain temps, ce liquide noircit et s'altère.

Bouilli avec du chlorure de calcium ou d'ammonium, le sucre s'intervertit.

Lorsqu'on soumet le sucre de canne à l'action de la levûre de bière, il fermente; mais, au préalable, il s'intervertit. La fermentation du sucre ne s'accomplit bien que si les liqueurs sont étendues.

Si, au lieu de soumettre le sucre à l'action de la levûre,

on abandonne à l'air sa solution aqueuse mêlée de phosphate d'ammoniaque, il se développe un ferment différent de la levûre de bière (1), qui le transforme également en acide carbonique et alcool, seulement l'inversion s'opère avec beaucoup plus de lenteur; quelquefois même elle n'est pas du tout apparente. M. Jodin a remarqué en outre que pendant l'été cette fermentation particulière s'accompagne d'une modification isomérique de la saccharose, et produit un nouveau sucre que nous étudierons plus loin sous le nom de *parasaccharose*.

Le sucre de canne est un puissant agent de conservation pour les substances animales et végétales.

Sous l'influence des oxydants, il donne de l'acide oxalique et de l'acide saccharique.

SUCRE INTERVERTI.

Nous avons dit que le sucre de canne s'intervertit sous l'influence des acides. Le sucre qui prend naissance dans ces circonstances est identique avec celui qui se rencontre dans le miel et dans les fruits acides. Il est incristallisable. Abandonné à lui-même pendant longtemps, il laisse déposer des cristaux de glucose.

Nous avons vu, en nous occupant de la lévulose, comment on pouvait extraire ce dernier corps du sucre interverti. Enfin nous avons parlé des modifications qu'éprouve son pouvoir rotatoire par la chaleur.

Pour compléter son étude et démontrer complétement que ce sucre est un mélange à poids égaux de glucose et de lévulose, il faut ajouter que, lorsque de la glucose s'est déposée en cristaux dans le sucre interverti, le pouvoir rotatoire de la partie restée liquide est devenu plus fortement lévogyre, mais qu'il suffit de redissoudre la glucose dans la partie li-

(1) Jodin, *Comptes rendus de l'Académie des sciences*, 1861, t. LIII, p. 1252.

quide au moyen d'une douce chaleur pour rendre au sucre interverti ses propriétés premières.

MÉLITOSE. $C^{12}H^{22}O^{11}$,3 aq.

La mélitose a été extraite, par M. Berthelot (1), de la manne d'Australie : exsudation sucrée produite par certaines espèces d'*Eucalyptus* de Van-Diemen.

On la prépare aisément en traitant par l'eau cette manne, décolorant la solution aqueuse par le charbon animal, faisant cristalliser, comprimant les cristaux dans du papier joseph, et purifiant le produit par une nouvelle cristallisation.

La mélitose cristallisée répond à la formule $C^{12}H^{22}O^{11}$,3 aq. A 100°, elle perd 2 aq, et à 130° elle perd le dernier; mais à cette température elle commence à s'altérer; si on la chauffe plus fort, elle se résout dans les principes qui prennent naissance lorsqu'on détruit les sucres par la chaleur.

La mélitose se dissout facilement dans l'eau; ses solutions ne deviennent pas sirupeuses avant de cristalliser, et ne sont point précipitées par l'alcool. Elles ont une tendance à se couvrir de moisissures.

La mélitose est dextrogyre; son pouvoir rotatoire est égal à + 102°; si l'on chauffe pendant un quart d'heure ce sucre avec de l'acide sulfurique, ce pouvoir rotatoire se modifie et tombe à + 163°; mais il ne change pas de signe, comme cela a lieu avec la saccharose.

La solution aqueuse de baryte n'altère pas la mélitose à 100°, et ce sucre n'exerce pas d'action réductrice sur le tartrate cupro-potassique.

L'acétate de plomb ammoniacal donne un précipité dans les solutions de mélitose.

L'acide chlorhydrique fumant transforme à l'ébullition ce principe sucré en des substances noires indéterminées.

(1) *Annales de chimie et de physique*, 3e série, t. XLVI, p. 66.

L'acide sulfurique étendu et bouillant communique à la mélitose la propriété de réduire le tartrate double de potasse et de cuivre.

Si l'on évapore, après l'avoir saturée, la liqueur qui contient la mélitose ainsi modifiée, on obtient un sucre sirupeux et incristallisable appartenant à la famille de la glucose.

Chauffée avec l'acide azotique, la mélitose fournit de l'acide mucique et de l'acide oxalique. Ce caractère la différencie nettement du sucre de canne. Enfin, sous l'influence de la levûre de bière, elle fermente, mais ne donne que la moitié de l'alcool et de l'acide carbonique que produirait dans les mêmes circonstances un poids équivalent de sucre de canne. Quand la fermentation est terminée, il reste dans la liqueur un principe sucré non fermentescible, l'eucalyne.

Si, au lieu de soumettre à la fermentation la mélitose, on met à fermenter le produit que ce sucre fournit, lorsqu'on le traite par l'acide sulfurique étendu, on obtient le même résultat : la moitié seulement de la masse se transforme en acide carbonique, alcool, etc., et il reste un poids d'eucalyne égal à la moitié du poids de la matière employée. Ceci tend à prouver que la mélitose, modifiée par les acides, constitue un mélange à équivalents égaux d'eucalyne et d'un sucre fermentescible. Si cela est, on peut calculer le pouvoir rotatoire de ce deuxième sucre en connaissant celui de l'eucalyne et de la mélitose modifiée; or, un pareil calcul donne pour ce nouveau sucre un pouvoir rotatoire à peu près égal à celui de la glucose ordinaire.

Ainsi, comme le sucre de canne, la mélitose paraît avoir un groupement complexe et contenir les éléments de deux autres sucres plus simples.

TRÉHALOSE. $C^{12}H^{22}O^{11}$,2 aq. (1).

La tréhalose a été extraite, par M. Berthelot, d'une manne venue de Turquie et qui porte le nom de *tréhala*.

(1) Berthelot, *Annales de chimie et de physique*, t. LV, p. 272.

Pour préparer ce principe sucré, on épuise le tréhala par l'alcool bouillant. La tréhalose cristallise parfois lorsque la liqueur se refroidit ; d'autres fois on est obligé d'évaporer et d'abandonner la solution à elle-même pendant quelques jours pour obtenir des cristaux. Ces cristaux doivent être exprimés avec du papier joseph et redissous dans de l'alcool bouillant ; on décolore la liqueur par le noir animal ; il suffit de l'abandonner au refroidissement, après l'avoir filtrée, pour que la cristallisation s'opère. La tréhalose ainsi obtenue, doit être purifiée par une ou deux nouvelles cristallisations dans l'alcool bouillant.

La tréhalose cristallise en octaèdres rectangulaires, durs, croquants sous la dent et doués d'une saveur sucrée. Ils ont pour formule : $C^{12}H^{22}O^{11} + 2$ aq. A 100°, ils perdent leur eau de cristallisation et sont alors représentés par la même formule que le sucre de canne.

Si l'on chauffe brusquement la tréhalose à 120°, elle peut fondre, mais si on lui fait subir lentement l'action de la chaleur, elle se déshydrate sans fondre, et on peut alors élever la température jusqu'à 180° sans décomposer ce sucre, qui est beaucoup plus stable que la saccharose ou la mélitose.

La tréhalose se dissout facilement dans l'eau, et cette solution devient sirupeuse avant de cristalliser ; elle se dissout également dans l'alcool bouillant, quoique à un degré moindre, très-peu dans l'alcool froid, et pas du tout dans l'éther.

La tréhalose est dextrogyre ; son pouvoir rotatoire moléculaire est égal à + 220° ; il est par conséquent triple de celui du sucre de canne. Il ne varie pas sensiblement avec la température, et il est après vingt-quatre heures ce qu'il était au moment où l'on venait de faire la dissolution, quand bien même cette dissolution aurait été faite avec de la tréhalose desséchée à 180°.

L'acide sulfurique étendu et bouillant attaque difficilement la tréhalose ; en prolongeant l'ébullition pendant quelques heures, on modifie le pouvoir rotatoire de ce sucre, qui devient quatre fois moins actif.

La tréhalose fermente difficilement par l'action directe de la levûre de bière ; lorsqu'elle a été préalablement modifiée par les acides étendus, la fermentation devient très-facile.

A 100°, la tréhalose n'est altérée ni par la potasse ni par la baryte, et elle ne réduit pas le tartrate de potasse et de cuivre. Ses solutions aqueuses sont précipitées par l'acétate de plomb ammoniacal.

L'acide chlorhydrique fumant noircit la tréhalose à 100° ; l'acide sulfurique concentré la charbonne à la même température ; quant à l'acide azotique, il l'oxyde avec production d'acide oxalique, mais jamais avec production d'acide mucique.

A 180°, ce sucre se combine aux acides stéarique, benzoïque, acétique et butyrique, et donne naissance à des corps analogues aux glucosides, aux mannitanides et aux corps gras.

MYCOSE. $C^{12}H^{22}O^{11}$ (1).

Le mycose a été extrait, par M. Mitscherlich, du seigle ergoté. Il épuise par l'eau la substance pulvérisée, précipite la liqueur par le sous-acétate de plomb, filtre et enlève l'excès de plomb par l'hydrogène sulfuré. La solution filtrée de nouveau et évaporée à consistance de sirop épais, laisse déposer des cristaux de mycose, qu'on lave à l'alcool froid, et qu'on purifie par plusieurs cristallisations.

Le mycose se confond avec la tréhalose par toutes ses propriétés, à l'exception de deux :

Il ne se déshydrate pas entièrement à 100°.

(1) Mitscherlich, *Monatsbericht der König Académie der Wissenschaffen zu Berlin*, 2 novembre 1857.

Son pouvoir rotatoire est plus faible que celui de la tréhalose.

MÉLÉZITOSE. $C^{12}H^{22}O^{11}$ (1).

La mélézitose a été extraite, par M. Berthelot, de la manne de Briançon, exsudation sucrée produite par le mélèze (*Pinus laryx*).

Pour préparer ce sucre, on traite la manne de Briançon par l'alcool bouillant, et l'on évapore la liqueur à consistance d'extrait. Au bout de quelques semaines, il se dépose des cristaux que l'on exprime et que l'on purifie en les faisant cristalliser de nouveau dans l'alcool bouillant.

Ces cristaux vus au microscope apparaissent comme des prismes rhomboïdaux obliques. Leur saveur est sucrée, mais bien moins que celle du sucre de canne ; ils possèdent une certaine quantité d'eau de cristallisation qui n'a pu être déterminée, parce qu'ils sont très-efflorescents. Desséchés à 110°, ils répondent à la formule $C^{12}H^{22}O^{11}$.

La mélézitose fond aux environs de 140°, et au-dessous de 200° elle se détruit en donnant les mêmes produits de décomposition que les autres sucres ; elle est très-soluble dans l'eau, d'où elle ne se dépose qu'après que les dissolutions sont devenues sirupeuses ; elle se dissout aussi un peu dans l'alcool bouillant, très-peu dans l'alcool froid, et pas du tout dans l'éther.

La mélézitose est dextrogyre ; son pouvoir rotatoire est égal à + 94°,1. Sous l'influence des acides étendus, et particulièrement de l'acide sulfurique, il se modifie et devient égal à celui de la glucose ordinaire. Cette modification exige environ une heure pour se produire ; elle est donc plus lente qu'avec le sucre de canne, et plus rapide qu'avec la tréhalose. Il est à remarquer que, pendant que l'action des acides dédouble le sucre de canne et la mélézitose en deux glucoses différentes, cette même action paraît avec la tréhalose et la mélézitose ne produire qu'un sucre unique.

(1) Berthelot, *Annales de chimie et de physique*, t. LV, p. 282.

La mélézitose est susceptible de subir la fermentation alcoolique, mais d'une manière lente et difficile. Au contraire, la fermentation se produit très-facilement, si l'on a soin de faire précéder l'action de la levûre de bière, de celle des acides étendus et bouillants.

Les alcalis n'altèrent point la mélézitose à 100°, et le tartrate cupro-potassique n'en est point réduit. L'acide sulfurique carbonise à froid cette matière sucrée, et l'acide chlorhydrique la brunit très-vite à la température de l'ébullition.

Sous l'influence de l'acide azotique, la mélézitose s'oxyde avec production d'acide oxalique, mais on n'observe jamais dans cette réaction la production de l'acide mucique.

LACTOSE. $C^{12}H^{22}O^{11}$ + aq.

La lactose n'a été trouvée jusqu'ici que dans le lait des mammifères, on l'en retire en coagulant le caséum que contient ce liquide par une petite quantité d'acide sulfurique. On filtre, on évapore, et l'on fait cristalliser. Les cristaux doivent être redissous dans l'eau, et leur dissolution décolorée par le noir animal, puis soumise de nouveau à la cristallisation.

Le sucre de lait cristallise en prismes rhomboïdaux obliques, d'une densité de 1,53. Il est dur, transparent, craque sous la dent, et ne présente qu'une saveur très-faiblement sucrée ; il se dissout à froid dans 6 parties d'eau avec production de chaleur, et à la température de l'ébullition dans 2 1/2 parties du même liquide.

L'alcool froid et l'éther ne le dissolvent pas. Les cristaux de lactose desséchés à 100° répondent à la formule $C^{12}H^{22}O^{11}$ + aq. Si on les chauffe à 150°, ils perdent leur eau de cristallisation, et peuvent alors être représentés par la même formule que le sucre de canne. A cette température, ils commencent, du reste, à s'altérer un peu, et à 170° ils se détruisent complétement.

Le sucre de lait est doué d'un pouvoir rotatoire dextrogyre. Ce pouvoir, rapporté à la formule $C^{12}H^{22}O^{11}$, est égal à + 59°,3. Il est plus fort de 3/8 avec les solutions récentes, mais il diminue rapidement pour atteindre ce terme constant.

Lorsqu'on chauffe le sucre de lait avec des acides minéraux étendus, ou avec des acides organiques énergiques, on le transforme en galactose, et son pouvoir rotatoire se trouve modifié.

La lactose s'altère à 100° sous l'influence de l'acide chlorhydrique fumant et de l'acide sulfurique concentré, en se carbonisant. L'acide chlorhydrique gazeux se combine à la lactose, en donnant une masse grise d'où l'acide sulfurique le chasse.

Oxydé par l'acide azotique, le sucre de lait fournit de l'acide mucique et de l'acide oxalique. M. Liebig (1) a en outre constaté dans cette réaction la formation de l'acide saccharique et de l'acide tartrique ordinaire.

Traitée par un mélange d'acides azotique et sulfurique, la lactose donne un produit nitré; ce produit, insoluble dans l'eau, se dissout dans l'alcool, et peut se déposer en cristaux de sa solution alcoolique ; il est explosible au-dessus de 100°.

La lactose se combine avec les bases, telles que la soude ou la potasse, dans la proportion de 1 équivalent de sucre pour 3 de base. On prépare ces combinaisons en dissolvant l'alcali dans la solution de sucre de lait et précipitant par l'alcool.

On peut retirer intact le sucre de lait de ces combinaisons obtenues à froid; mais si l'on chauffe ces dernières à 100°, elles jaunissent et se détruisent à la manière des glucosates.

Lorsqu'on dissout du sulfate de cuivre dans une solution

(1) *Annalen der Chemie und Pharmacie*, t. CXIII, p. 1 (nouvelle série, t. XXXVII, janvier 1860).

de sucre de lait, et qu'on ajoute de la potasse à la solution, il se forme un précipité qui se dissout de nouveau. Si l'on ajoute une plus grande quantité de potasse, il se produit un dépôt d'oxydule de cuivre ; cette réduction est favorisée par une douce chaleur. La lactose réduit également le tartrate cupro-potassique ; seulement, si l'on prend des quantités de glucose et de lactose, qui contiennent le même poids de carbone, on remarque que le sucre de lait réduit moins d'oxyde de cuivre que la glucose. Les quantités réduites sont entre elles comme 10 : 7.

Le sucre de lait ne fermente pas en présence de la levûre de bière, mais, en présence des substances animales, une portion se transforme en galactose, qui subit la fermentation alcoolique, tandis que la majeure partie se transforme en acides acétique et butyrique. Selon M. Luboldt (1), il se produit toujours une certaine quantité d'alcool, lorsque le sucre de lait fermente entre 15° et 20° ; mais à mesure que l'acidité se manifeste, la quantité d'alcool produite diminue, sans toutefois s'arrêter complétement.

La solution du sucre de lait est précipitée par l'acétate de plomb ammoniacal.

L'acide tartrique se combine avec la lactose à la température de 100°.

PARASACCHAROSE. $C^{12}H^{22}O^{11}$.

La parasaccharose n'est autre que le sucre isomérique avec le sucre de canne, dont nous avons mentionné la production dans une fermentation spéciale de la saccharose (2). Voici les propriétés de ce nouveau sucre :

La parasaccharose est très-soluble dans l'eau sans être hygrométrique ; l'alcool à 90° ne la dissout pas sensiblement.

A 100° elle se colore et paraît se décomposer un peu.

(1) *Journal für praktische Chemie*, 1859, t. LXXVII, p. 282, n° 13.
(2) Jodin, *loc. cit.*

Desséchée dans le vide à 15°, elle répond à la formule $C^{12}H^{22}O^{11}$. La parasaccharose est dextrogyre ; son pouvoir rotatoire est égal à environ + 108° à 10° : il ne varie pas dans les premiers moments de la dissolution.

La parasaccharose réduit le tartrate cupro-potassique ; mais son pouvoir réducteur est inférieur à celui de la glucose et même de la lactose. Des équivalents égaux de ces trois sucres réduisent des quantités d'oxyde de cuivre qui sont entre elles comme 10 : 7 : 5.

Comme la lactose, la parasaccharose est donc intermédiaire entre les sucres qui appartiennent franchement à la famille de la saccharose, et ceux qui se groupent autour de la glucose.

La parasaccharose n'est pas modifiée par l'acide sulfurique étendu, à 100°, même après une heure. Au contraire, l'acide chlorhydrique brunit ses solutions, élève son pouvoir réducteur au niveau de celui de la lactose et abaisse son pouvoir rotatoire au niveau de celui de la saccharose.

CHAPITRE IV.

FONCTIONS DES SUCRES.

Les sucres sont des alcools ; ce n'est plus douteux depuis que M. Berthelot est parvenu à les combiner synthétiquement avec les acides avec élimination d'une certaine quantité d'eau, en donnant naissance à des corps analogues aux corps gras et saponifiables comme ces derniers. Un second fait définitivement fixé aujourd'hui, c'est que les sucres sont des alcools polyatomiques. Si l'on chauffe un sucre avec une quantité donnée d'acide acétique dans un tube scellé à la lampe, et qu'à l'ouverture du tube on dose la quantité d'acide resté libre par un essai volumétrique, on constate la neutralisation d'une certaine quantité d'acide.

Qu'on extraie et qu'on purifie avec soin le composé neutre qui a pris naissance, qu'on le chauffe une seconde fois dans un tube scellé avec de l'acide acétique ; à l'ouverture du tube un essai volumétrique démontre qu'une certaine quantité d'acide a été neutralisée. Un tel phénomène ne peut se produire qu'avec un alcool polyatomique. Lorsqu'on se sert d'un alcool ordinaire, il y a bien production d'un éther, mais cet éther n'a plus d'action sur de nouvelles portions d'acide.

Ainsi, les sucres sont des alcools, et des alcols polyatomiques. Il faut savoir seulement si ces alcools sont simples, comme le glycol ou la glycérine, ou condensés, comme les glycols polyéthyléniques et les alcools polyglycériques ; enfin, quel est le degré de leur atomicité.

Pour cela, prenons successivement les sucres de chaque groupe, et discutons-en les réactions.

D'abord la mannite et la dulcite.

Ces composés ont pour formule $C^6H^{14}O^6$, qui leur assigne 6 atomes d'oxygène ; or, nous savons qu'en général l'atomicité des alcools simples est égale à la quantité d'oxygène qu'ils contiennent; nous pouvons donc déduire à priori de cette règle générale, que la mannite est un alcool hexa-atomique. Si nous traitons la mannite par l'acide azotique, nous obtenons un produit nitré qui représente l'éther hexanitrique de cet alcool, et qui a pour formule rationnelle $\left.\begin{matrix} C^6H^{8vi} \\ 6(AzO^4) \end{matrix}\right\} O^6$. Cet éther est d'autant plus utile pour fixer l'atomicité de la mannite, que son azote est un élément nouveau introduit dans la combinaison, et que, par suite, les quantités de cet élément varient pour un seul équivalent d'acide azotique dans des proportions telles, que les erreurs inévitables de l'analyse organique ne peuvent plus fausser nos conclusions.

Les produits qu'on obtient, en combinant la mannite ou la dulcite avec les acides acétique ou butyrique, ont une propriété remarquable que nous avons déjà signalée. Lorsqu'on les saponifie, ils ne régénèrent pas l'alcool primitif et l'acide qui entre dans leur constitution, mais bien cet acide et un anhydride de la mannite ou de la dulcite, — la mannitane ou la dulcitane. — M. Berthelot considère ces anhydrides comme de véritables alcools dont la mannite et la dulcite ne seraient que des hydrates, et il leur assigne une atomicité égale à 6.

Il est vrai que la mannitane et la dulcitane sont des alcools. L'étude des composés polyatomiques nous a montré d'une manière certaine que les anhydrides d'un alcool conservent les fonctions alcooliques, pourvu qu'il leur reste une certaine quantité d'hydrogène typique; mais je n'admets pas : 1° que la mannite et la dulcite ne soient pas des alcools par elles-mêmes; 2° que l'atomicité de la mannitane ou de la dulcitane soit égale à 6.

En effet, l'étude des alcools condensés montre, comme

l'a très-bien fait remarquer M. Lourenço, qu'à mesure que les composés se compliquent, le composé fondamental a de moins en moins de stabilité, et les anhydrides de plus en plus de tendance à se produire. D'autre part, d'après M. Baüer, tandis que le glycol ordinaire a une stabilité telle qu'on l'obtient par l'action directe de l'oxyde d'éthylène sur l'eau, l'amylglycol, au contraire, paraît subir une déshydratation très-faible sous l'influence de la chaleur. Ce même chimiste a montré que lorsqu'on s'élève dans la série jusqu'au glycol diamylénique, on peut bien encore obtenir les éthers composés de cet alcool, mais non le glycol lui-même; dans la saponification du diacétate de diamylène, par exemple, au lieu du glycol diamylénique, c'est l'oxyde de diamylène qui prend naissance.

Appliquons ces données à la mannite et à la dulcite; les faits deviennent d'une clarté extraordinaire. Lorsqu'on chauffe la mannite avec un acide, il se produit un éther hexa-atomique, mais lorsqu'on cherche à saponifier cet éther, le groupe mannite n'ayant pas une stabilité suffisante pour résister à l'ébranlement moléculaire qu'on lui fait subir, on n'obtient que le premier anhydride de cet alcool, la mannitane.

Vient-on maintenant à chauffer la mannitane avec un acide, elle commence par se saturer en se combinant à un équivalent de l'acide hydraté, à la manière de l'oxyde d'éthylène ou de l'épichlorhydrine ; il se produit ainsi un éther mono-acide de la mannite qui, par une action éthérifiante ultérieure, peut se transformer en mannite di-tri... hexa-acide.

La seule objection que M. Berthelot puisse faire à cette manière rationnelle d'interpréter les faits, c'est que les analyses des composés dont nous parlons ne répondent point à la formule d'une mannite hexa-acide, et répondent au contraire à celle d'un éther hexa-acide de la mannitane. M. Berthelot cherche même à établir qu'il y a entre les formules de ces deux composés une différence plus grande que celle qui peut résulter d'une erreur d'analyse. Ce fait serait vrai si l'on pouvait être absolument sûr de la pureté du produit, mais comme la mannitane peut, après tout, jouer le rôle d'un alcool tétra-atomique, puisqu'elle contient encore quatre atomes d'hydrogène typique, on peut très-bien avoir des mélanges d'éthers mannitiques et d'éthers mannitaniques, que l'analyse est impuissante à déterminer ; enfin, il n'est pas impossible que, lorsqu'on chauffe à 200° de la mannite avec un acide, la portion de ce sucre, qui n'entre pas en réaction, se transforme en mannitane, et que cet anhydride, se combinant à l'éther mannitique déjà produit, ne donne naissance à des composés condensés qui viennent encore augmenter la confusion.

En résumé, nous considérons la mannite et la dulcite comme des alcools hexa-atomiques ; la mannitane et la dulcitane sont des anhydrides pouvant jouer le rôle d'alcools tétra-atomiques, mais ayant une tendance plus grande à se combiner aux acides sans élimination d'eau pour régénérer un éther mono-acide de leurs alcools respectifs.

L'oxydation de la mannite vient à l'appui de notre manière de voir. Si c'est la mannitane qui joue le rôle d'alcool, le premier acide de cet alcool aura pour formule $C^6H^{10}O^6$, et le second $C^6H^8O^7$, ainsi que l'indiquent les deux équations ci-dessous :

$$\underbrace{C^6H^{12}O^5}_{\text{Mannitane.}} + O^2 = H^2O + \underbrace{C^6H^{10}O^6}_{\text{Premier acide.}}$$

$$\underbrace{C^6H^{12}O^5}_{\text{Mannitane.}} + O^4 = H^4O^2 + \underbrace{C^6H^8O^7}_{\text{Deuxième acide.}}$$

Si, au contraire, c'est la mannite qui fait fonction d'alcool, les deux premiers acides qui en dériveront par oxydation auront pour formule $C^6H^{12}O^7$ et $C^6H^{10}O^8$, comme le démontrent les deux équations suivantes :

$$\underbrace{C^6H^{14}O^6}_{\text{Mannite.}} + O^2 = H^2O + \underbrace{C^6H^{12}O^7}_{\text{Premier acide.}}$$

$$\underbrace{C^6H^{14}O^6}_{\text{Mannite.}} + O^4 = H^4O^2 + \underbrace{C^6H^{10}O^8}_{\text{Deuxième acide.}}$$

Or, l'acide $C^6H^{12}O^7$ n'est autre que l'acide mannitique obtenu par M. Gorup Besanez en oxydant la mannite par le noir de platine, et l'acide $C^6H^{10}O^8$ n'est autre que l'acide saccharique obtenu par l'oxydation de la mannite au moyen de l'acide azotique, ou l'acide mucique obtenu en traitant la dulcite par le même agent.

Le problème qui nous reste à résoudre est celui-ci : la mannite est-elle un alcool simple ou un alcool condensé ? Il n'est pas douteux qu'elle ne soit un alcool simple. Deux ordres de faits également importants l'établissent : 1° dans les alcools condensés, le nombre d'atomes d'oxygène est supérieur au nombre d'atomes d'hydrogène typiques que contient l'alcool, et nous venons de constater que la mannite est hexa-atomique.

Les quantités d'hydrogène typique et d'oxygène contenues dans ce corps sont donc les mêmes. La mannite est un alcool simple.

2° En traitant les alcools polyatomiques simples, la glycérine par exemple, par l'acide iodhydrique, on obtient l'éther iodhydrique de l'alcool mono-atomique de la même série. Si, au contraire, on soumet à l'action de cet acide un alcool condensé, on donne naissance à des corps dont la molécule contient moins de carbone que le composé primitif : c'est ainsi que, dans ce cas, l'alcool diéthylénique donne, non pas de l'iodure de butyle, mais de l'iodure d'éthylène (1).

Or, en soumettant la mannite à l'action de l'acide iodhydrique, MM. Wanklin et Erlenmeyer ont obtenu l'iodure

(1) Wurtz, *Expériences inédites.*

d'hexyle, qui contient autant de carbone que la mannite elle-même.

La mannite est donc un alcool hexa-atomique non condensé, et sa formule rationnelle doit s'écrire $\left.\begin{matrix} C^6H^{8\,\text{VI}} \\ H^6 \end{matrix}\right\} O^6$.

Il en est de même de la dulcite, qui, soumise à l'action de l'acide iodhydrique, a donné les mêmes résultats.

Examinons maintenant la glucose et ses congénères.

Ces corps ont évidemment pour formule $C^6H^{12}O^6$. Ce ne sont pas des produits de condensation, car on sait que, sous l'influence de l'hydrogène naissant, ces sucres se transforment en mannite; comme la mannite, ils jouent le rôle d'alcools. Ici deux hypothèses se présentent : ou bien ce sont des alcools hexa-atomiques, comme la mannite, mais isologues de cette dernière, c'est-à-dire présentant vis-à-vis d'elle le même rapport que l'alcool acétylique vis-à-vis de l'alcool éthylique, ou que l'alcool allylique vis-à-vis de l'alcool propylique ; ou bien ils représentent le premier aldéhyde de la mannite, et jouent à la fois le rôle d'alcools penta-atomiques et d'aldéhydes mono-atomiques.

M. Berthelot émet les deux hypothèses sans les résoudre.

Le fait de l'hydrogénation directe des glucoses et de leur transformation en mannite ne peut en rien nous éclairer sur ce point. L'alcool allylique, ainsi que l'a vu M. Lourenço, se transforme en alcool propylique tout aussi bien que l'aldéhyde en alcool. La réaction est donc possible dans les deux hypothèses, et ne jette aucun jour sur la question.

Mais, jusqu'ici, nous ne connaissons aucun alcool qui, en s'oxydant, perde de l'hydrogène et donne naissance à un nouvel alcool isologue du premier. Dans ce cas, c'est toujours un aldéhyde qui se forme. Or, M. Gorup Besanez (1) a obtenu une glucose par l'oxydation de la mannite, et cette réaction donne un grand poids à la deuxième manière d'envisager les glucoses.

(1) Gorup Besanez, *loc. cit.*

Voici une autre preuve : la glucose par les oxydants se transforme en acide saccharique. Cette oxydation ne s'explique bien qu'en admettant que la glucose est un alcool-aldéhyde, car alors seulement ce corps pourra fixer un atome d'oxygène avant de subir une nouvelle substitution. Quant à savoir si ce sont les glucoses ou les glucosanes qui sont des alcools, nous aurions à répéter à ce sujet tout ce que nous avons dit à l'occasion de la mannite. D'ailleurs, nous nous éloignons beaucoup moins ici des opinions de M. Berthelot, qui admet des éthers de glucoses et des éthers de glucosanes comme étant possibles les uns et les autres.

En résumé, nous considérerons les glucoses comme jouant le rôle d'aldéhydes mono-atomiques et d'alcools penta-atomiques, et comme étant susceptibles de produire des anhydrides, des glucosanes, faisant alors fonctions d'alcool.

Nous devons ajouter, toutefois, que parmi les nombreux isomères de la glucose, il pourrait bien s'en trouver qui répondissent à la première hypothèse et fussent des alcools hexa-atomiques isologues de la mannite. La composition de l'inosite hexanitrique nous porterait même à considérer l'inosite de cette manière.

A côté des glucoses, nous placerons la pinite et la quercite, qui, ayant la même quantité d'hydrogène, doivent se rapporter, selon nous, à la même série.

Établissons d'abord qu'il n'y a aucun rapport entre ces deux sucres et leur homologue, la mannitane. La mannitane diffère de la pinite et de la quercite par une propriété fondamentale : abandonnée à l'air libre, ou chauffée avec de l'eau de baryte, elle s'hydrate et donne de la mannite. Dans ces conditions, la pinite et la quercite restent inaltérées. La pinite et la quercite ne sont donc pas des anhydrides, car elles manquent de la propriété caractéristique de ce groupe de corps : la propriété de s'hydrater.

Ce point une fois établi, la double hypothèse qui vient d'être posée au sujet des glucoses se retrouve ici : ou la pinite et la quercite sont des alcools penta-atomiques isologues d'un alcool inconnu dont la formule serait $C^6H^{14}O^5$, ou ce sont des aldéhydes mono-atomiques dérivant de ce même alcool inconnu, et jouant le rôle d'alcools tétra-atomiques. Jusqu'ici, aucune réaction ne permet de trancher la question; le moyen le plus simple d'y arriver consisterait à transformer la pinite ou la quercite en l'alcool inconnu dont nous parlons, au moyen de l'hydrogène naissant. On verrait ensuite si cet alcool régénérerait ou non ces corps par l'oxydation. Si la régénération avait lieu, on en conclurait la nature aldéhydique de la pinite, sinon, on serait conduit à penser que ce corps est simplement un alcool penta-atomique.

Nous disons que si la pinite et la quercite ne sont que des alcools, ils doivent avoir une atomicité égale à 5, parce qu'ils possèdent 5 atomes d'oxygène, et cependant, nous avons admis que la mannitane isomère de ces deux corps peut fonctionner comme un alcool tétra-atomique. Ce fait n'a rien qui doive étonner : tout alcool polyatomique en se déshydratant perd 2 atomes d'hydrogène typique par molécule d'eau éliminée. Les corps qui résultent de cette perte d'eau ont une atomicité inférieure d'une unité à celle des alcools d'une autre série qui sont isomères avec eux. C'est ainsi que l'oxyde d'éthylène dérivé du glycol ne possède plus d'hydrogène typique, tandis que l'alcool acétylique, son isomère, en possède 1 atome. Si la pinite et la quercite ne jouent pas d'autre rôle que celui d'alcool, elles présentent vis-à-vis de la mannitane la même relation que l'alcool acétylique vis-à-vis de l'oxyde d'éthylène.

A côté de la pinite et de la quercite, se place l'érythrite, sur laquelle il n'y a plus de discussion possible, M. de Luynes, ayant définitivement établi sa formule $C^4H^{10}O^4$, qui en fait l'alcool tétra-atomique de la série butylique.

Il nous reste maintenant à parler du sucre de canne et de ses isomères.

Un fait domine l'étude de ces corps : ils sont susceptibles

de se dédoubler en s'hydratant, et de fournir ainsi deux sucres différents. Il est vrai que ce fait, aisément constatable pour la mélitose et la saccharose, l'est moins en ce qui concerne la tréhalose et la mélézitose; mais en présence de l'analogie de propriétés qui existe entre tous ces corps, il est probable que la tréhalose et la mélézitose subissent le même dédoublement; seulement ce dédoublement n'est pas constatable, parce qu'au lieu de se produire ici deux sucres différents, il se produit deux équivalents d'un seul et même sucre; en un mot, il paraît y avoir entre le dédoublement de la tréhalose et celui de la saccharose la même relation que nous trouvons entre le dédoublement de l'éther ordinaire et celui de l'éther mixte méthyl-éthylique.

De ces réactions, nous sommes obligé de déduire que les sucres de cette classe contiennent dans leur molécule deux groupements séparés, qu'en un mot, on doit les considérer comme des alcools condensés, et représenter leur composition par la formule rationnelle

$$\left.\begin{matrix} C^6H^{6\,VI} \\ C^6H^{6\,VI} \\ H^{10} \end{matrix}\right\} O^{11}.$$

dans laquelle C^6H^6 peut représenter deux fois le radical hexa-atomique d'un seul et même sucre, ou les deux radicaux de deux sucres différents.

S'il en est ainsi, et que ces sucres soient assez stables pour se combiner quelquefois avec les acides sans se détruire, il résulte de leur formule même qu'ils doivent jouer le rôle d'alcools déka-atomiques. On conçoit quelles difficultés présente la solution expérimentale d'un pareil problème en présence surtout de l'extrême instabilité des composés dont il s'agit.

La fonction des sucres étant établie jette une lumière nouvelle sur un certain groupe de corps, tels que l'amygdaline, l'arbutine, la phillyrine, la salicine, l'esculine, la populine, etc., corps qui, on le sait, sont susceptibles d'absorber de l'eau, et de se dédoubler en glucose et en une foule d'autres produits, parmi lesquels on trouve des acides, des aldéhydes, de l'ammoniaque, des phénols. Il est évident que ces composés sont des glucosides, ou, plus généralement, des saccharides qui se saponifient à la manière des dérivés des alcools. Nous n'avons donc pas à nous étendre plus longtemps sur ces substances. Un fait seulement nous arrêtera : le fait que présente la saponification de la populine. Lorsqu'on hydrate cette dernière, elle ne se résout pas immédiatement en acide benzoïque, saligénine et glucose. Si les actions sont ménagées on obtient d'abord de l'acide benzoïque et de la salicine. Ce n'est que par une action ultérieure que la salicine se transforme en saligénine et en glucose.

On voit par là que, dans la saponification des glucosides, on peut, si l'action est convenablement choisie et suffisamment ménagée, retirer un à un, pour ainsi dire, les divers produits qui entrent dans la composition de ces corps.

Ce phénomène, qui ne présente aucune utilité pour le chimiste lorsque les divers principes constituants d'un glucoside sont bien différents, en présente au contraire de bien marqués lorsqu'on a affaire à un produit de condensation dans lequel n'entre qu'un seul et même principe. M. Berthelot a su déjà tirer de là des considérations relatives à l'amidon qui nous paraissent intéressantes et que nous croyons utile de reproduire. L'analyse de l'amidon conduit aux rapports $C^6H^{10}O^5$; mais l'analyse ne pouvant fixer le degré de complication moléculaire, nous ignorons si $C^6H^{10}O^5$ représente la vraie formule de l'amidon, ou si cette formule est un multiple de la précédente. La forme organisée que présente l'amidon, et qui ne se rencontre guère qu'avec des composés fort compliqués, doit nous faire pencher pour une formule multiple de $C^6H^{10}O^5$; mais quel sera ce multiple? C'est ce que nous ignorons.

D'un autre côté, si nous considérons les divers alcools condensés dérivés de la glucose, nous leur trouverons les formules suivantes :

$$\underbrace{\left.\begin{array}{c} C^6H^{6\,VI} \\ C^6H^{6\,VI} \\ H^{10} \end{array}\right\}}_{\text{Alcool diglucosique.}} O^{11} = C^{12}H^{22}O^{11}, \text{ dont le premier anhydride est } C^{12}H^{20}O^{10}.$$

$$\left.\begin{array}{c} C^6H^{6\,VI} \\ C^6H^{6\,VI} \\ C^6H^{6\,VI} \\ H^{14} \end{array}\right\} O^{16} = C^{18}H^{32}O^{16}, \text{ dont le premier anhydride est } C^{18}H^{30}O^{15}.$$

Il suffit de jeter un coup d'œil sur ces formules pour constater que les deux anhydrides $C^{12}H^{20}O^{10}$ et $C^{18}H^{30}O^{15}$ sont des multiples des rapports $C^6H^{10}O^5$ adoptés pour l'amidon ; l'amidon pourrait donc être ou l'anhydride de l'alcool diglucosique ou l'anhydride de l'alcool triglucosique, ou l'alcool triglucosique lui-même, parce qu'avec un tel degré de complication moléculaire, l'analyse ne saurait décider entre deux formules aussi rapprochées que $C^{18}H^{32}O^{16}$ et $C^{18}H^{30}O^{15}$.

Si l'amidon est l'anhydride diglucosique, il doit, sous les influences hydratantes, se résoudre d'un seul coup en deux molécules de glucose. Mais si l'amidon est l'anhydride ou l'alcool triglucosique, il devra être possible, en ménageant convenablement les réactions, de le dédoubler premièrement en glucose et en alcool diglucosique, et de dédoubler ensuite par une action plus énergique l'alcool diglucosique lui-même en 2 équivalents de glucose.

Or c'est ce dernier cas qui se présente, ainsi que nous avons eu déjà l'occasion de le dire. M. Musculus a vu que lorsqu'on fait agir la diastase sur l'amidon, celui-ci se dédouble en dextrine et glucose, et l'on sait que sous l'influence des acides, la dextrine se saccharifie à son tour. L'amidon doit donc être considéré comme l'alcool ou l'anhydride triglucosique. Lorsqu'on le saccharifie, il se transforme d'abord en un équivalent de glucose et de dextrine qui représente l'anhydride diglucosique ; celle-ci peut ensuite se scinder à son tour en deux molécules de glucose. Nous représenterons donc, avec M. Berthelot, l'amidon par une des deux formules

$$C^{18}H^{32}O^{16}$$
$$C^{18}H^{30}O^{15}.$$

A côté de l'amidon se place un autre principe qui lui est isomère, la cellulose. Il est évident que si l'amidon est un produit de condensation, la cellulose doit en être un aussi. On ignore s'il existe plusieurs celluloses différentes ; on n'en connaît qu'une seule ; mais il est certain que les moyens dont on se sert pour la purifier (action des alcalis ou des acides bouillants) pourrait ramener à cet état unique des produits beaucoup plus compliqués.

Quoi qu'il en soit, dans la saccharification de la seule cellulose que nous connaissons, on n'a pas observé de dédoublement analogue à celui que subit l'amidon.

Une autre considération, cependant, amène M. Berthelot à ne considérer la cellulose que comme un produit de première condensation. Lorsque deux molécules d'un alcool se combinent en éliminant de l'eau, chacune perd une de ses affinités, si bien que l'atomicité du composé est inférieure de deux unités au double de l'atomicité de l'alcool primitif. Si donc on suppose que les deux alcools qui se combinent soient de nature différente, et que l'un soit susceptible de subir six fois une réaction que l'autre ne saurait subir une seule fois, le produit de condensation sera capable d'éprouver cinq fois cette réaction. En admettant que des deux sucres qui entrent dans la constitution de la cellulose, et qui tous deux doivent être hexa-atomiques, un seul fût attaquable par l'acide azotique, la cellulose devrait être, elle aussi, attaquable par cet acide, mais ne devrait pouvoir donner qu'un dérivé pentanitrique ; or c'est là ce qui arrive, les chimistes n'ayant jamais pu remplacer dans ce corps plus de 5 atomes d'hydrogène par de l'hypo-azotide.

Ce raisonnement ne nous paraît pas probant. Si la cellulose était le résultat de la condensation de trois molécules d'un ou de plusieurs alcools, une de ces trois molécules aurait bien perdu deux atomes d'hydrogène typique, mais les deux autres n'en auraient perdu qu'une seule. Dès lors chacune de ces molécules aurait encore 5 équivalents d'hydrogène remplaçables ; et si l'un de ces deux alcools était attaquable par l'acide nitrique, à l'exclusion de l'autre et de celui qui aurait perdu deux de ses hydrogènes typiques, on aurait encore cinq pour limite de la substitution nitreuse.

Le raisonnement que nous venons de faire peut s'appliquer à des produits quatre, cinq, six fois condensés. La remarque de M. Berthelot ne prouve donc rien relativement au degré de condensation de la cellulose.

Ces considérations sur l'amidon et la cellulose sont d'une haute importance. Si les faits qu'elles font pressentir étaient rigoureusement démontrés, ces deux corps ne seraient plus les générateurs des sucres ; ils seraient au contraire engendrés par eux.

Du reste, si, comme certaines expériences encore incomplètes tendent à le prouver, l'albumine, la gélatine et la chondrine étaient des dérivés ammoniacaux des sucres, les sucres deviendraient le foyer de production de toutes les substances organisées, l'élément premier de la vie.

Ces questions sont sans doute encore très-obscures, et ne laissent pas espérer une solution prochaine ; mais les hypothèses auxquelles elles donnent lieu se déduisent des faits que nous connaissons avec une logique si ferme, et sont d'une importance si grande, que j'ai cru de mon devoir de les indiquer ici.

CHAPITRE V.

USAGES PHARMACEUTIQUES DES SUCRES.

On ne fait usage en pharmacie que de deux produits sucrés : le sucre de canne et le miel.

Le sucre de canne entre dans la composition de toute une classe de médicaments désignés sous le nom de *saccharolés;* il est destiné à rendre ces médicaments plus agréables au goût ou à favoriser leur conservation. Dans la classe des saccharolés sont : les sirops, les mellites, les conserves, les gelées, les oléo-saccharums, les saccharures, les pâtes, les tablettes et les pastilles.

Les *sirops* sont des médicaments coulant très-lentement et ne devant leur consistance qu'au sucre qu'ils renferment. Ils sont d'une grande utilité ; ils permettent de présenter le médicament sous une forme qui n'affecte pas trop désagréablement le goût des malades ; ils facilitent la conservation des sucs qu'on n'a pas toujours frais, et ils offrent une solution de concentration constante.

Les *mellites* sont des sirops dans lesquels le miel remplace le sucre. Ils s'altèrent plus vite que les sirops.

Les *conserves* s'obtiennent par l'association du sucre à une pulpe végétale. Elles sont destinées à conserver les pulpes que l'on ne peut avoir fraîches toute l'année. Malheureusement on arrive rarement à ce résultat ; le plus souvent les conserves fermentent et s'altèrent au bout de quelques mois. On donne presque toujours aux conserves une consistance de pâte molle ; quelquefois elles sont solides, celles d'ache et d'angélique par exemple.

Les *gelées* sont surtout caractérisées par leur consistance tremblotante. Il y a des gelées animales et des gelées végétales. Les premières doivent leur consistance à la géla-

tine ; les secondes la doivent tantôt à la matière amylacée, c'est le cas de la gelée de lichen d'Islande, tantôt à des composés pectiques : on peut alors les conserver plus facilement.

Les *pâtes* sont des médicaments qui ont la consistance de la pâte de boulanger arrivée à un degré de fermeté suffisant pour ne plus adhérer aux doigts ; elles se composent de gomme et de sucre. Les substances médicamenteuses qu'on y associe n'ont généralement aucun effet.

Les *oléo-saccharums* sont des mélanges intimes de sucre et d'une huile essentielle. On les prépare en broyant ensemble 4 grammes de sucre et une goutte d'essence. On peut encore frotter un morceau de sucre avec la partie végétale qui fournit l'essence et pulvériser ensuite. On opère ainsi avec les écorces des fruits des hespéridées.

Les *saccharures* sont des mélanges intimes et pulvérulents d'une substance médicamenteuse et de sucre. On les prépare en dissolvant ensemble cette substance et le sucre, en évaporant la solution et en pulvérisant le résidu. On peut les obtenir aussi par simple pulvérisation.

Les *tablettes* et les *pastilles* sont des pâtes durcies et cassantes. Comme elles doivent favoriser l'ingestion de certaines substances, en améliorant leur goût, il faut éviter d'y faire entrer des médicaments dont la saveur serait très-désagréable.

On réserve plus particulièrement le nom de *pastilles* à ceux de ces médicaments qui ont été obtenus par la cuite du sucre et qui ne contiennent que du sucre et des aromates.

Parmi les formes pharmaceutiques de ce groupe, une seule, celle des sirops, comporte des développements généraux. Nous allons en faire une étude détaillée.

DES SIROPS.

Nous avons défini les sirops ; nous ajouterons que les liquides qui entrent dans leur constitution sont très-variables. Ce sont généralement des liqueurs aqueuses; quelquefois on y fait entrer des liqueurs vineuses ou alcooliques, comme dans le sirop de quinquina au vin. Les sirops de cette espèce sont même trop négligés et mériteraient une plus large place dans le Codex.

Un bon sirop doit être clair, limpide et ne pas fermenter. On réalise cette dernière condition en mettant le sucre et l'eau dans la proportion de 1000 parties de sucre pour 530 parties d'eau, ou 66 parties de sucre pour 34 d'eau. Si le sirop était moins concentré, il fermenterait; s'il l'était plus, il cristalliserait. Ce dernier inconvénient est plus grave qu'il ne paraît l'être : lorsqu'un sirop a commencé à laisser déposer en cristaux le sucre qu'il contient, ce sucre est pour ainsi dire entraîné; le sirop finit par ne plus être assez concentré et il fermente. Si les liqueurs dont on se sert pour la fabrication des sirops étaient elles-mêmes sucrées, il faudrait, bien entendu, modifier les proportions précédentes.

Nous allons décrire les divers modes opératoires à l'aide desquels on obtient le sirop de sucre et les sirops médicamenteux; nous résumerons ensuite un mémoire très-important qui a été présenté en 1861 à la Société de pharmacie sur ce sujet (1).

Sirop de sucre.

Le sirop de sucre peut être préparé par simple solution ou par coction et clarification.

Dans le premier cas, on dissout 66 parties de sucre dans 34 parties d'eau en s'aidant d'une douce chaleur. On laisse refroidir le liquide et on le met en bouteilles. Ce procédé exige l'emploi du sucre raffiné de première qualité. Si le sucre n'était pas très-blanc, il faudrait agiter le sirop avec un peu de noir animal et le filtrer ensuite au papier.

(1) *Journal de pharmacie et de chimie*, t. XL, p. 381 et 472.

La méthode par coction et clarification est plus compliquée; elle comporte des procédés divers :

1° *Clarification par l'albumine.* — On dissout le sucre brut dans une quantité d'eau supérieure à celle que doit contenir le sirop; on ajoute à la solution des blancs d'œuf délayés dans l'eau, et l'on porte lentement le tout à l'ébullition; puis, on écume et l'on ajoute de l'eau albumineuse, alternativement. Enfin on filtre et l'on achève d'évaporer, afin d'amener le sirop au degré de concentration voulu.

2° *Clarification par l'albumine et le noir.* — On opère comme dans le cas précédent; seulement on ajoute à l'albumine une certaine quantité de noir en poudre, ce qui rend la clarification plus facile. On peut encore, après avoir clarifié par l'albumine, filtrer à travers une caisse pleine de noir animal en grains, comme dans l'industrie. Cette méthode débite beaucoup et donne un sirop de fort belle qualité.

Nous avons déjà dit qu'après la clarification on devait évaporer jusqu'à concentration convenable. Il existe plusieurs moyens pour reconnaître si l'on a atteint ce degré; trois seulement peuvent être recommandés au pharmacien : la balance, l'aréomètre, le thermomètre.

Si l'on veut faire usage de la balance, il faut tarer d'abord la bassine où l'on fait l'évaporation, peser le sucre et porter de temps à autre la bassine sur le plateau de la balance. Lorsque le poids de son contenu est égal à celui du sucre employé augmenté du poids de l'eau que l'on veut laisser dans le sirop, il est temps d'arrêter l'opération.

Avec le thermomètre, on cesse l'évaporation lorsque la température du liquide bouillant s'élève à 105°.

Le procédé par l'aréomètre est le plus sûr et le plus commode. Il consiste à plonger un pèse-sirop dans le liquide en ébullition. La cuite est terminée lorque l'instrument marque 30° si l'on est en hiver, ou 30°,5 si l'on est en été, de façon à marquer 35° après refroidissement, ce qui correspond à une densité de 1,261.

A ces moyens de reconnaître le degré de la cuite d'une solution de sucre s'en ajoutent d'autres fondés sur les caractères physiques du sirop. Ceux-ci exigent une grande pratique et ne peuvent donner qu'une exactitude médiocre; aussi nous n'en conseillons point l'usage et nous nous dispensons de les décrire.

Sirops médicinaux.

On obtient les sirops médicinaux : 1° par simple solution; 2° par solution et évaporation; 3° par clarification avec l'albumine; 4° par mélange avec le sirop de sucre et évaporation; 5° par mélange avec le sirop de sucre sans évaporation; 6° par clarification au papier.

1° *Simple solution.* — Le manuel opératoire est le même que pour le sirop de sucre. Il suffit de remplacer l'eau par des eaux distillées, des infusés, des macérés, des décoctés, des sucs de plantes, etc. On peut aussi faire usage de ce procédé avec les liqueurs extractives. Dans ce cas, il faudrait commencer par évaporer les liqueurs jusqu'à ce qu'elles aient été ramenées à un volume déterminé.

2° *Solution et évaporation.* — On dissout le sucre dans un excès de véhicule et l'on évapore ensuite. On se sert de ce procédé pour les sirops faits avec les sucs dépurés, comme les sirops de nerprun, d'ortie, de fumeterre; on s'en sert aussi pour le sirop de quinquina.

3° *Coction et clarification.* — On opère avec l'albumine comme s'il s'agissait du sirop de sucre. M. Salles a proposé de ne point écumer, d'abandonner au repos et de décanter lorsque l'albumine s'est déposée. Cette modification est heureuse, pourvu que les liquides contiennent assez d'impuretés pour rendre l'albumine lourde et en faciliter la précipitation.

4° *Mélange au sirop de sucre et évaporation.* — On mêle le liquide médicamenteux avec le sirop de sucre et l'on évapore. Ce procédé dispense de l'emploi du sucre raffiné; on

s'en sert de préférence pour les liquides très-aqueux. Si la solution est extractive, on mêle le sirop aux dernières portions d'eau qui ont servi à épuiser le végétal; on évapore au delà du point nécessaire et l'on décuit ensuite avec les premières portions de liqueur mises en réserve. De cette manière, on évite l'altération par la chaleur, des parties actives auxquelles il est nécessaire de conserver toutes leurs propriétés. C'est ainsi qu'on opère avec la douce-amère, les cinq racines, la pensée sauvage, la mousse de Corse, etc.

5° *Simple mélange avec le sirop de sucre sans évaporation.* — Si le liquide à ajouter est peu abondant, et s'il n'est pas nuisible de diminuer un peu le degré de cuisson du sirop, on fait simplement le mélange. Ce procédé est employé avec les solutions de certaines substances chimiques, comme le chlorhydrate de morphine et le sulfate de protoxyde de fer. On l'emploie aussi si la liqueur est abondante, pourvu qu'elle ne dépasse pas le poids de l'eau que le sirop peut perdre par évaporation. Dans ce cas on cuit le sirop jusqu'à ce qu'il ait perdu une quantité d'eau égale à celle du liquide qu'on se propose d'y ajouter, puis on opère le mélange; le meilleur moyen d'évaluer la quantité d'eau que le sirop a perdue consiste à faire usage de la balance.

6° *Clarification au papier.* — On réduit en bouillie du papier joseph humecté d'eau, on le mêle avec le sirop et l'on filtre sur un morceau de laine attaché à un cadre de bois. On doit se servir de ce procédé toutes les fois que l'on a des substances qui exercent une action chimique sur l'albumine.

Les *mellites* se préparent exactement comme les sirops. Seulement on emploie 3 parties de miel pour 1 partie d'eau. On ne fait jamais bouillir les mellites, parce qu'ils sont très-altérables; on ajoute du vinaigre à ces produits lorsqu'on veut obtenir ce que l'on désigne sous le nom d'*oxymels*.

D'après le rapport de la commission chargée par la Société de pharmacie de s'occuper de la question des sirops, ces formes pharmaceutiques se divisent en deux classes :

Première classe, *sirops simples;* deuxième classe, *sirops composés.*

Première classe. — Les sirops simples forment quatre groupes :

Premier groupe. — Il contient les sirops dans la composition desquels le liquide entre pour 66 parties et le sucre pour 34. Ce groupe se subdivise en quatre genres : dans le premier, le liquide est l'eau pure, et l'on n'y trouve que le sirop de sucre; dans le second, le liquide est une eau distillée, comme dans le sirop d'eau de fleur d'oranger; le troisième genre est caractérisé par la nature du véhicule, qui est une solution aqueuse; dans le dernier se placent les sirops obtenus :

A. Par la solution d'un médicament chimique; *B*, en traitant un végétal par expression, macération, infusion, digestion, décoction, déplacement par l'eau alcoolisée; *C*, à l'aide d'une substance animale.

Deuxième groupe, comprenant les sirops obtenus avec 64 parties de sucre pour 36 parties de liquide.—Il n'est formé que d'un seul genre caractérisé par le véhicule, qui est un suc végétal fermenté : le sirop de cerises appartient à ce groupe.

Troisième groupe. — Ici la commission met des sirops qui contiennent 62 parties de sucre et 38 parties de liquide; dans ce groupe il n'y a qu'un sirop, le sirop d'orgeat ; on pourrait peut-être en préparer d'autres de la même manière avec des liqueurs émulsives.

Quatrième groupe. — On y range les sirops faits avec des liqueurs vineuses, et contenant 44 parties de vin pour 56 parties de sucre : exemple, sirop de quinquina au vin.

Deuxième classe. — Les sirops composés doivent être préparés suivant les méthodes usitées pour les sirops simples; ils diffèrent de ces derniers par le nombre des substances médicamenteuses qui entrent dans leur composition.

Après avoir tracé cette classification, le rapport de la commission passe en revue les divers modes opératoires, et expose sur chacun d'eux des règles importantes, dont quelques-unes trouvent ici leur place.

Lorsqu'on fait usage d'un soluté d'une substance chimique, il ne faut pas se servir d'un sirop clarifié à l'albumine, et l'on doit faire le mélange à froid.

Sont considérés comme excellents, au point de vue de leur conservation ou de leur limpidité, les sirops obtenus avec les liquides produits par expression d'un végétal.

On ne généralisera pas l'emploi des sirops faits avec des solutions d'extraits. Ces sirops sont bons tout au plus pour des potions; il faut les rejeter lorsqu'on les destine à édulcorer ou à remplacer les tisanes.

L'infusion est un mode d'épuisement avantageux avec les substances aromatiques, pourvu qu'on laisse infuser pendant un laps de temps toujours rigoureusement le même, et qu'on emploie toujours la même quantité d'eau. Deux infusions successives sont nécessaires lorsqu'on opère sur des bois qui s'imbibent difficilement; le liquide de la deuxième infusion est converti en sirop. On cuit ce dernier au delà du degré ordinaire, et on le ramène à ce degré, en y ajoutant la liqueur de la première infusion.

On avait proposé de distiller les plantes aromatiques, de faire un sirop avec l'eau distillée et un sirop avec la décoction qui reste dans la cucurbite, et de mêler ces deux sirops. Le rapport de la commission repousse ce procédé, comme devant altérer les substances par une décoction prolongée.

La digestion est réservée aux principes résineux, et la décoction à quelques rares substances qui ne céderaient pas autrement leurs parties solubles, telles que les substances animales.

La commission repousse dans le plus grand nombre des cas le procédé de M. Boudet, d'après lequel on épuise le végétal par de l'alcool étendu, on chasse l'alcool par l'ébullition, et l'on convertit en sirop le liquide restant. Ce procédé présente le double inconvénient de donner des liqueurs troubles, et de fournir des sirops qui contiennent de l'alcool, ce qui peut en modifier les propriétés. Cette méthode peut cependant être appliquée avec succès à la préparation du sirop de quinquina : dans ce cas on prend de l'alcool à 32° de l'alcoomètre centésimal.

Lorsqu'on prépare un sirop avec des sucs de fruits acides, il y a à craindre l'inversion du sucre par suite de l'action de l'acide ou de celle d'un ferment. Il faut éviter autant que possible cette altération, car la glucose étant moins soluble que le sucre de canne, se dépose en cristaux et abaisse le degré du sirop. On prévient cette inversion en chauffant le moins possible, et en n'abandonnant pas le suc à la fermentation pendant plus de vingt-quatre heures. Il faut cependant chauffer un peu pour détruire le ferment. Dans le cas où l'on emploierait des sucs conservés par le procédé d'Appert, on se passerait, dans la préparation du sirop, de l'action de la chaleur ; les sucs ainsi conservés ont été soumis à une température de 100° et n'ont plus de ferment.

Dans la préparation des sirops composés, on mêle les substances qui ont le plus d'analogie ; on soumet séparément ces mélanges à l'action des dissolvants, après les avoir divisés de la façon la mieux appropriée. On réunit ensuite ces divers liquides, et l'on termine comme avec les sirops simples.

Les sirops contenant des substances extractives sont placés dans des flacons de faible capacité, on les laisse le moins longtemps possible en vidange, et on ne les expose pas à une température supérieure à 15°.

On empêche les sirops de moisir en versant dans le goulot du flacon un peu de sirop de sucre, il ne faut pas se servir de l'alcool ni du sulfite de soude, que l'on a indiqués pour remplir le même usage ; ce sont des corps étrangers qui altéreraient les qualités du médicament.

CHAPITRE VI.

SACCHARIMÉTRIE.

La saccharimétrie a pour objet : 1° de déterminer si un corps contient du sucre de canne ou un sucre de la famille des glucoses ; 2° de reconnaître si le sucre de canne est mélangé de glucose ; 3° de doser ces principes lorsqu'ils sont seuls et lorsqu'ils sont réunis.

On reconnaît facilement le sucre de canne ou la glucose, en soumettant à l'action de la levûre de bière la liqueur qui les contient. On constate qu'il se forme de l'alcool et de l'acide carbonique.

On reconnaît aussi directement la glucose au moyen des réactifs dont nous allons parler, et à l'aide desquels on met également en évidence le sucre de canne, après l'avoir interverti par l'acide sulfurique étendu et bouillant, ou par l'acide chlorhydrique.

Si l'on veut constater la présence de la glucose, seule ou mêlée à du sucre de canne, il faut avoir recours à l'un des procédés suivants.

En faisant bouillir la solution sucrée avec de la potasse ou de la soude, une coloration brune de cette solution annonce la présence de la glucose.

Il vaut mieux employer le tartrate double de potasse et de cuivre en solution alcaline. Ce réactif n'est pas attaqué à l'ébullition par le sucre de canne ; tandis que, dans ces conditions, la glucose ou le sucre interverti en précipitent du sous-oxyde de cuivre de couleur rouge. Ce réactif est très-sensible.

On a également conseillé l'emploi du bichromate de potasse. Sous l'influence de ce composé, la solution de sucre de canne verdit pendant qu'on laisse refroidir le mélange fait à l'ébullition. La solution de la glucose ne prend, dans ce cas, aucune teinte verte. Il suffit même qu'un sucre de canne renferme un tiers de son poids de glucose pour qu'il cesse de manifester la teinte verte qui le caractérise. Au-dessous d'un tiers, la glucose n'empêche plus cette coloration d'apparaître, mais son intensité est plus faible qu'elle ne serait si le sucre était pur.

La partie la plus importante de la saccharimétrie est le dosage du sucre et de la glucose. Les procédés de dosage sont basés soit sur les propriétés chimiques, soit sur les propriétés physiques de ces corps.

Procédés chimiques.

A. *Fermentation.* — Ce moyen d'analyse n'est plus en usage, et n'est pas exact. Il consistait à faire fermenter un poids connu de sucre pur, et à mesurer l'acide carbonique formé, ou à apprécier la quantité d'alcool au moyen de l'alcoomètre centésimal. On faisait ensuite fermenter la matière à analyser, et l'on déduisait le poids du sucre du volume d'acide carbonique, ou du poids de l'alcool qu'elle fournissait.

Lorsque la matière renfermait à la fois de la glucose et du sucre, on appréciait d'abord le poids du mélange par une première fermentation, puis on détruisait la glucose par une ébullition de quelques minutes avec un alcali ; une deuxième fermentation donnait alors le poids du sucre de canne, et l'on déterminait celui de la glucose par différence.

Aujourd'hui on préfère le procédé de M. Barreswil. Ce procédé est basé sur la réduction des solutions alcalines des sels de cuivre par la glucose. On fait une solution avec 40 grammes de sulfate de cuivre pur cristallisé, 600 ou 700 grammes de lessive de soude caustique d'une densité de 1,12, et 160 grammes de tartrate neutre de potasse

dissous dans un peu d'eau. On verse peu à peu la solution cuivrique dans la liqueur alcaline, et l'on étend le mélange d'un volume d'eau suffisant pour lui faire occuper 1154,4 centimètres cubes, à la température de 15°.

Pour doser cette liqueur, on intervertit un certain poids de sucre candi ; on place la solution, après en avoir mesuré le volume, dans une burette graduée, et on la verse ensuite goutte à goutte dans un petit ballon contenant 10 centimètres cubes de la liqueur cuivrique, additionnés de 40 centimètres cubes d'eau distillée et portés à l'ébullition. Il se forme un précipité jaune d'abord, puis rouge, qui gagne le fond du vase. On arrête l'opération quand la liqueur cuivrique est décolorée, et de la quantité de liquide sucré employé on déduit le poids de sucre qui correspond à 10 centimètres cubes de la liqueur d'épreuve. Ordinairement, quand la liqueur a été préparée avec les proportions que nous avons indiquées, 10 centimètres cubes correspondent à 0,050 de glucose sèche.

La liqueur d'épreuve une fois dosée, rien n'est plus facile que de déterminer la quantité de sucre qu'un liquide contient, pourvu qu'il ne contienne pas en même temps d'autres corps capables de réduire le tartrate cupro-potassique. Il suffit d'examiner, par une opération identique avec la précédente, combien il faut employer de ce liquide sucré pour décolorer un volume connu du réactif ci-dessus.

Si l'on avait un mélange de sucre de canne et d'un sucre réducteur à analyser, on doserait d'abord le sucre réducteur, puis on intervertirait le sucre de canne, et l'on ferait un nouveau dosage. En retranchant de la quantité totale de sucre obtenu dans cette seconde opération la quantité de sucre réducteur donné par la première, on aurait le sucre de canne par différence.

Nous devons, pour être complet, mentionner le procédé de M. Péligot et celui de M. Dubrunfaut.

M. Péligot conseille de saturer de chaux les liquides sucrés, de déterminer ensuite cette base par une solution titrée d'acide sulfurique, et de déduire la quantité de sucre de la quantité de chaux. Ce procédé ne donne pas de résultats exacts, parce que le sucrate de chaux dissous dans l'eau ne présente pas une composition constante.

Le procédé de M. Dubrunfaut est beaucoup plus exact. Ce chimiste conseille de faire bouillir la liqueur à analyser avec une dissolution titrée de soude caustique. On détermine ensuite la soude restée libre à l'aide d'une solution titrée d'acide sulfurique, ce qui permet de calculer le poids de l'alcali entré en combinaison avec les acides dérivés de la glucose. On déduit de là le poids de ce dernier sucre, le rapport entre le poids de la glucose et celui de la soude transformée en sel neutre ayant été déterminé par une expérience préalable.

On fait ensuite bouillir une seconde portion du liquide à analyser avec de l'acide sulfurique étendu, pour intervertir la saccharose, et sur la matière obtenue on dose de nouveau le sucre réducteur par le même procédé. Il est nécessaire ici de défalquer, du poids de la soude combinée, celle qui a servi à saturer l'acide sulfurique dont la solution était titrée. Le sucre de canne se trouve déterminé par différence.

Saccharimétrie optique.

Lorsqu'un rayon de lumière se réfléchit sous certaines influences, ou se réfracte en passant à travers un cristal biréfringent, il acquiert la propriété de s'éteindre lorsqu'on cherche à le faire se réfléchir ou se réfracter dans des conditions telles, que s'il n'était pas déjà modifié, il passerait et prendrait un plan perpendiculaire à celui qu'il a déjà. On dit alors que ce rayon est polarisé.

On a constaté que lorsqu'un rayon de lumière polarisée tombe sur un cristal biréfringent, dans des conditions convenables pour qu'il s'éteigne, il suffit d'interposer sur son

passage une lame de certaines substances transparentes ou des tubes remplis avec des dissolutions particulières, pour le faire apparaître de nouveau.

Si l'on cherche alors à éteindre une seconde fois le rayon, on est obligé, pour produire cet effet, de changer la position du cristal analyseur (c'est ainsi que l'on nomme le cristal biréfringent qui éteint la lumière) et de le tourner d'un certain nombre de degrés soit à gauche, soit à droite. On dit, dans ce cas, que la substance interposée dévie vers la gauche ou vers la droite le plan de polarisation de la lumière, qu'elle est lévogyre ou dextrogyre.

M. Biot a constaté qu'il y a toujours un rapport direct entre 1° la déviation observée, 2° l'épaisseur de la substance, 3° sa densité, 4° son pouvoir rotatoire spécifique. Ce pouvoir spécifique n'est autre que la déviation du plan de polarisation que produirait la substance que l'on observe, si son épaisseur était égale à unité, et que sa densité fût aussi ramenée à l'unité par une modification convenable de la distance de ses molécules.

Il résulte de la définition ci-dessus que l'on aura le pouvoir rotatoire moléculaire d'une substance de densité connue d et d'épaisseur l, en divisant la déviation observée α, par la densité et par l'épaisseur, comme l'indique l'égalité :

$$\rho = \frac{\alpha}{dl}, \tag{1}$$

dans laquelle ρ est le pouvoir rotatoire spécifique recherché.

Dans une solution, d représente la densité de la substance active dissoute. Cette densité peut être facilement calculée, si l'on connaît le poids de la substance p et le volume de la dissolution v ; la substance active occupe, en effet, le même volume que la dissolution entière, et sa densité est donnée par l'équation :

$$d = \frac{p}{v}. \tag{2}$$

Si nous remplaçons dans l'équation (1) d par sa valeur, il vient :

$$(3) \qquad \rho = \frac{\alpha}{\frac{lp}{v}} = \frac{\alpha v}{lp},$$

équation qui permet de déterminer ρ, lorsque α, v, l, p sont connus. Réciproquement, on pourrait, si ρ était connu, et qu'une des valeurs α, v, l, p fût inconnue, déterminer cette valeur; par exemple, le poids serait donné par l'égalité :

$$(4) \qquad p = \frac{\alpha v}{\rho l}.$$

Appliquons à présent ces données à l'analyse des sucres.

Nous savons que le sucre de canne dévie vers la droite le plan de polarisation de la lumière, et que son pouvoir rotatoire spécifique est égal à $+ 73,8$; si nous avons une dissolution de ce corps, et que cette dissolution observée au polarimètre, dans un tube dont la capacité et la longueur soient connues, donne une déviation $= \alpha'$, nous n'aurons qu'à remplacer dans la formule (4) les valeurs générales α, v, ρ, l par les valeurs trouvées dans l'expérience; en effectuant les calculs, nous aurons le poids du sucre que la dissolution contient.

Supposons maintenant que le sucre de canne soit mélangé avec de la glucose qui, comme lui, tourne à droite; il faudra, pour connaître les quantités respectives de ces deux sucres, déterminer la part qui appartient à chacun d'eux dans la rotation totale.

Pour y arriver, on intervertit le sucre de canne en chauffant la solution pendant quelques minutes à 68° avec 0,1 d'acide chlorhydrique; après quoi, on examine de nouveau la déviation α'' que donne la liqueur. Seulement, comme l'état de dilution de cette dernière a été augmenté par l'addition de l'acide chlorhydrique, il faut remplacer la déviation observée α'' par $\frac{10}{9}\,\alpha''$.

On a alors toutes les données nécessaires au calcul.

La déviation α', avant l'inversion, était égale à la somme des déviations individuelles x du sucre de canne et y de la glucose. Après l'inversion, $\frac{10}{9}\alpha''$ représente la déviation y de la glucose, qui n'a pas varié, diminuée de la rotation vers la gauche, due au sucre interverti. Cette rotation est égale à $r\,x$, si l'on admet qu'un poids de sucre de canne déviant de x donne une quantité de sucre incristallisable déviant de rx (r ayant été déterminée par l'expérience).

On peut donc poser les deux équations :

$$\text{Avant l'inversion, } x + y = \alpha',$$
$$\text{Après l'inversion, } y - rx = \alpha'' \times \frac{10}{9},$$

qui suffisent à la détermination des deux inconnues.

Si, au lieu d'être mêlé à la glucose, le sucre de canne était mêlé à du sucre interverti qui tourne à gauche, les équations ci-dessus prendraient la forme suivante :

$$\text{Avant l'inversion, } x - y' = \alpha';$$
$$\text{Après l'inversion, } y' + rx = \alpha'' \times \frac{10}{9}.$$

y' représente la déviation qui provient du sucre interverti. Comme le pouvoir rotatoire de ce dernier sucre varie beaucoup avec la température, M. Clerget a construit des tables de correction qui permettent d'opérer à quelque température que ce soit.

Actuellement on remplace souvent l'appareil de M. Biot par celui de M. Soleil. Ce saccharimètre, que je ne décrirai pas, porte avant le prisme analyseur un double quartz formé de deux lames de quartz, l'une lévogyre et l'autre dextrogyre. Ces lames sont toutes deux taillées en biseau, et en montant ou en descendant l'une d'elles, on diminue ou l'on augmente l'épaisseur qu'elle offre aux rayons lumineux. Quand elles sont au même niveau, ces deux lames se compensent exactement ; si alors on place convenablement le prisme analyseur, on amène une teinte qui sert de point de comparaison et qui a reçu le nom de *teinte sensible*.

Quand on veut faire usage de l'appareil, on le prend exactement compensé et à la teinte sensible, et l'on place sur le trajet du rayon lumineux le tube qui contient la substance. La teinte sensible est alors détruite, et, pour la ramener, il faut diminuer l'épaisseur de la lame de quartz de même rotation que la matière examinée. Une échelle munie d'un vernier indique en centièmes de millimètre la diminution d'épaisseur ; d'où l'on déduit la proportion de sucre qui se trouve dans la dissolution. La quantité de sucre qui, dans un tube de longueur et de capacité déterminées, correspond à une certaine épaisseur de quartz, est préalablement connue par l'expérience.

Lorsque le procédé saccharimétrique que nous venons de décrire peut être appliqué, il est le plus exact de tous. Malheureusement, la présence de substances étrangères actives ou la coloration des liqueurs à essayer en rendent souvent l'emploi incertain ou impossible. Cependant on peut se préserver, dans la plupart des cas, de l'action fâcheuse de la coloration, en précipitant par l'acétate de plomb, qui entraîne les principes colorants, et en filtrant le liquide après cette précipitation.

RÉSUMÉ GÉNÉRAL.

Les corps appelés *sucres* ne forment point une famille naturelle. On les trouve disséminés dans la série indéfinie des composés organiques.

Leur classification est artificielle.

Les sucres se divisent en quatre groupes, dont les trois derniers ont des caractères qui leur sont propres. Ils renferment les principes analogues à la glucose, les sucres analogues à l'inosite et les corps isomères du sucre de canne. Le premier groupe, tout arbitraire, se subdivise en trois genres : le premier de ces genres contient la mannite et la dulcite ($C^6H^{14}O^6$), le second la pinite et la quercite ($C^6H^{10}O^5$), et le dernier l'érythrite ($C^4H^{10}O^4$).

La mannite et la dulcite sont des alcools hexa-atomiques simples ; ils fournissent chacun un anhydride. Cet anhydride se combine directement aux acides et donne un éther monoacide de l'alcool qui lui correspond. Il joue aussi le rôle d'alcool tetra-atomique, et peut probablement s'unir aux éthers de son alcool pour former des produits de condensation.

Les mannitanides et les dulcitanides donnent, dans leur saponification, la mannitane et la dulcitane, et non la mannite et la dulcite. On a expliqué ce fait par le peu de stabilité des groupes mannite et dulcite.

L'inosite est un alcool hexa-atomique isologue de la mannite.

De même pour les glucoses. Cependant, il est plus rationnel de considérer ces corps comme des aldéhydes du premier degré dérivés de la mannite ou de corps isomères, et fonctionnant en même temps comme des alcools penta-atomiques.

La pinite et la quercite peuvent être tout aussi bien des alcools penta-atomiques isologues d'un alcool inconnu ($C^6H^{14}O^5$), que des aldéhydes-alcools dérivés du même corps.

L'érythrite est un alcool tétra-atomique.

Le sucre de canne et ses isomères sont des alcools diglucosiques, formés aux dépens de deux molécules d'une seule glucose (tréhalose, mélézitose) ou de deux glucoses différentes (mélitose, saccharose).

L'amidon est probablement l'anhydride de l'alcool triglucosique, ou cet alcool, comme on le déduit de son dédoublement en glucose et dextrine qui se saccharifie elle-même.

Nous ne savons rien de certain sur la cellulose.

Les hypothèses de M. Berthelot sur l'amidon et la cellulose, les idées qui ont été émises dans ces dernières années sur les principes azotés contenus dans les corps vivants, font entrevoir la classe des sucres comme un foyer de production de toutes les substances organisées.

FIN.

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TABLE DES MATIÈRES.

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Miss Ann Muirhead Shearer, *Housekeeper.*

ANNUAL REPORT

BY THE DIRECTORS OF

JAMES MURRAY'S ROYAL ASYLUM

FOR LUNATICS.

8th JUNE, 1863.

It is now the duty of the Directors to submit the Thirty-Sixth Annual Report of the Institution.

At the date of the last Annual Report there were in the House 178 patients—85 males and 93 females. Since then 47 patients have been admitted—24 males and 23 females. The total number of patients under treatment during the year was 225—109 males and 116 females. From this total fall to be subtracted 30 discharges and removals—16 males and 14 females; and 15 deaths—6 males and 9 females. The items of the discharges and removals were 15 recoveries—7 males and 8 females; 9 discharges or removals *improved*—6 males and 3 females; and 6 *unimproved*—3 patients of either sex. There thus now remain in the Asylum 180 patients—87 males and 93 females, being 2 more than at the same period last year.

During the past year a considerable expenditure has been made in effecting improvements of different kinds in the Institution, which will contribute to the enjoyment of the patients; among which may be mentioned the erection of a handsome greenhouse, workshops, and storehouses.

For further particulars in regard to the history and experience of the Institution during the past year, reference is made to the Report by Dr Lindsay, the Physician.

During the past year the Institution has been conducted with a satisfactory measure of success, although in the providence of God it has been deprived of two of its most devoted Directors, John Marshall, Esq. of Rosemount, and Lieutenant-General John Murray Belshes. The Directors earnestly trust that through the Divine blessing this Asylum may long continue to confer important benefits on the community.

WM. PEDDIE, *Chairman.*

REPORT OF PHYSICIAN

FOR THE YEAR 1862–3.

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REPORT OF PHYSICIAN

FOR THE YEAR 1862-3.

General changes in population.

FROM the circumstance that the *in*coming and *out*going patients,—the admissions on the one hand, and the discharges, removals, and deaths, on the other,—during the bygone year have nearly balanced each other, our population stands very much *in statu quo* as compared with the previous year,—the actual figures being 180 patients this, as contrasted with 178 last, year.

The principal changes in the said population during the year 1862-3 may be concisely stated thus. At the date of last annual meeting, there were in the Institution 178 residents, 85 males and 93 females. To these have to be added, in the course of the year that has since elapsed, 47 admissions, 24 males and 23 females; making the total number of inmates during the past year 225, 109 males and 116 females. From this total fall to be substracted 30 discharges and removals, 16 males and 14 females; and 15 deaths, 6 males and 9 females. The items of the discharges and removals were 15 recoveries, 7 males and 8 females; 9 discharges or removals *im*proved, 6 males and 3 females; and 6 *un*improved, 3 of either sex. There are thus still left resident 180 patients, 87 males and 93 females.

Admissions.

The *Admissions* during the past year exceed those of the previous year by 11. Their numbers have, however, as usual been limited or determined by the vacancies created by discharges, removals, and deaths, as well as by the amount of available space depending on variations in the numbers of the non-pauper classes of patients. Though from time to time, to a certain extent relieved by the transfer to other asylums, at the instance of the Directors, of considerable numbers of incurable paupers, as well as by the more ordinary changes in our population, the overcrowded condition of the Establishment, of which we have had cause to complain, more especially during the last five years, has never been materially diminished; for, almost as speedily as vacancies have been created or relief obtained by the measures or causes above-

Limitation by over-crowded state of house.

mentioned, the said vacancies have been filled up by fresh, clamant cases—thus ever necessitating fresh sources or modes of relief.

Refusals of admission.

The extent to which our accommodation and resources have proved inadequate to the wants—of the district mainly—may be gathered from the number of *refusals of admission* in 1862, which amounted to 20, 3 in private and 17 in pauper cases. During the last four years there has been an average annual refusal of admission in 20 cases, 4 being private or non-pauper, and 16 pauper patients. From the evils of overcrowding, of deficient accommodation, of inability to meet the demand constantly made on our resources, we have at length, however, the definite prospect of speedy relief in the approaching completion and opening of the Perth District Asylum for paupers at Murthly, to which our entire pauper population, amounting to an average of 100 patients, 50 of either sex, will be drafted probably during the spring or summer of 1864.

Transfers *from* Asylums and Poor-houses.

Several of the admissions were patients transferred from other asylums or from poor-houses; and these for the most part fall to be added to our yearly increasing accumulation of incurables,—the class which impedes and clogs all the curative machinery of an hospital, which ought to be devoted to active treatment,—the class which is gradually, but inevitably, causing the degeneracy of all our public hospitals for the insane into mere receptacles or retreats for the hopeless. Of our present population there is an average of only from 5 to 8 per cent. of the males, and from 20 to 25 per cent. of the females, or from 15 to 20 per cent. of both sexes, that can be considered curable. Under this category we include such cases as have a prospect of ultimate and permanent recovery; along with those in which we can only expect intermissions of sanity, or temporary and intermittent recovery.

Relative proportion of curable and incurable.

These two classes of cases are, however, mostly recent admissions, to which we give the benefit of the most favourable prognosis in the absence of a sufficiently long acquaintance with the patients to warrant or enable us to predicate otherwise or more confidently. In all likelihood, as we have had occasion to indicate in a previous report,* the proportion of the whole population at any given period resident that will really recover satisfactorily does not exceed *five* per cent.

Recoveries.

The *Recoveries* do not bulk very largely in proportion to the admissions, or to the number of residents. But this arises, on the one hand, from a disposition to *under*, rather than *over*-estimate the number of recoveries; and, on the other, from the class of entrants and residents, a large proportion of whom, as has been already pointed out, are incurable cases. To the tabulated number of recoveries, however, may perhaps be legitimately added certain patients discharged *im*proved, whose recovery, in progress at the period of discharge, has

* 33d Annual Report (1860), page 12.

probably since been completed or consolidated. With one exception, all the patients discharged recovered would appear to have in reality recovered, so far as this can be judged of by the experience of a few months subsequent to discharge. Fully recognizing, however, the difficulty of determining, and the danger of certifying, the reality or permanence—the quality or degree of a recovery, we are, and have been, in the habit of discharging *all* apparently recovered cases, whether private or pauper, *as on probation*, the probation period varying with the means or exigencies of the patient, and his relatives or guardians.

Probation removals.

In all cases supervision and care are recommended for a time: and in individual instances it is in addition counselled that, as a tentative or experimental measure, as well as a means of establishing the recovery and improving the physique, the patient should travel; visit distant friends; indulge in a fallow idleness; resume customary occupations to a limited extent, or entirely alter these or their scene; give up former residences or practices; or act upon and carry out a more specific scheme of future self treatment.

Removals improved.

Of the patients discharged or removed *improved* three were removed on probation at our instance or suggestion, in order that they might have the benefit of the crucial test of free family country life; while the remainder were removed by their relatives, in some cases with our sanction to probation removal, in others in opposition to, or in despite of, our opinion and advice.

Removals unimproved.

Of the patients discharged or removed *un*improved, three paupers were transferred by the Parochial Board of Perth to the recently opened lunatic wards of the Perth Poor-house, where we have since visited them, and where they seem comfortably treated and well cared for.

Transfers *to* Asylums and Poor-houses.

Two paupers were transferred to the Montrose Asylum by Parochial Boards of distant parishes at the instance of the Directors of this Institution, in order to assist in relieving for the time our over-crowded condition, consequent on or produced by the sudden influx of cases, that could not, from the nature of their claims on our accommodation, be refused. The remaining case was a removal by relatives in direct opposition to medical advice.

Mortality:

As contrasted with the *mortality* of the previous year, which was unusually small, that of 1862-3 has been unusually large, larger indeed than it has been during the last seven years. This, however, arises from causes admitting of easy and satisfactory explanation.

its causes.

There has been no devastating epidemic in operation; mortality has arisen from the ordinary causes of death in an institution, which has reached comparative age, and from certain exceptional causes, which occasionally operate notwithstanding every precaution to guard against them. The Institution has now reached such an age—36 years—that

Accumulation of the aged and infirm.

its earlier entrants, most of whom were in the vigour of life on admission, have reached, while some have passed, the average span of human existence; and their demise in the natural cycle of life's changes was to be looked for, as the simple result of senility and the diseases or affections to which it is incident. Two deaths were those of patients over 70 years of age; while other five patients were between 60 and 70 years old at the time of decease. One patient had been nearly 35 years a resident in the Institution; a second, 32 years; and a third, 26 years. In all of these cases death was mainly attributable to age; and in all death would probably have occurred at a much earlier period out of an asylum.

Physical complications: or co-existent diseases.

Several patients were admitted labouring under physical complication or diseases of such a character, or to such degree or extent, that death resulted from these pre-existing affections within various short periods after admission: in two cases within seven days; in other two within ten; in a fifth within six weeks; in a sixth within two and a-half months; in a seventh within seven, and in two others within nine months. In most of these cases the physical diseases were so serious and frequently so complicated that recovery therefrom was almost or altogether impossible; and all that could be effected by medical science and art was to prolong life, in some instances for months or weeks, by careful nursing, and the administration of nutrients and stimulants. In one case there was a combination of vertebral caries, empyema, heart disease, and a cut-throat wound; in a second strangulated femoral hernia, with acute enteritis therefrom resulting, was associated with broncho-pneumonia; in a third acute gastro-enteritis was the result of a dissolute or intemperate life; in a fourth a malignant umbilical tumour, deeply rooted in the abdomen, and also associated with malignant mesenteric and other abdominal tumours, co-existed with apoplexy; in a fifth extensive valvular and other organic disease of the heart co-existed with pneumonia; while in a sixth there was extensive tubercular disease of the lungs, intestines, and other viscera, which had reduced the patient to a state of extreme emaciation and debility prior to admission. In other cases, again, the exhaustion of mania, acute or chronic, was super-added to that of senility. We cannot afford space to go into pathological detail, and must therefore refer for further particulars to our Obituary tables contained in the appendix to this report.

Assistance of professional experts in special cases.

The permissive clause contained in the regulations for the guidance of the Physician, conferring on him the power, at his discretion, of availing himself, in difficult or special cases,—mostly of a surgical nature,—of the assistance of *experts or specialists* from what quarter and of what character soever he may deem fit, has proved a

most valuable one. For months or even years no accident may occur, no emergency arise, no patient require such extraneous assistance. But suddenly contingencies occur, and they occur generally in groups or series, for which the ordinary resources of the Institution are inadequate, and in which the promptest assistance of the highest authorities readily accessible is indispensable. So seldom do casualties occur requiring—for instance—operative interference that it is probably undesirable and unnecessary that an hospital for the insane should possess itself of a complete set of surgical apparatus or instruments, which would imply a very heavy expenditure, and would probably be providing for contingencies which will never happen, or laying in a stock of appliances which, when in the course of years required, will be found antiquated and unsuitable. It would be equally inexpedient, however, to be altogether unprovided with a certain kind and amount of surgical necessaries, even with this valuable permissive power as to the assistance of professional experts. Emergencies occasionally occur of such a character that there is no time to call in extraneous aid, or that it is unnecessary or inexpedient to do so;—in which case the resident medical staff is called upon for immediate, unhesitating action. In order to provide for actual surgical wants, we have found it necessary to provide within a few years such apparatus or instruments as trocars and canulas for hydrocele; tracheotomy tubes; probangs and throat forceps; sets of catheters, of tooth forceps, of operating bistouries; stomach pumps and enema apparatus of various kinds; syringe for the subcutaneous injection of narcotics; trusses for hernias; splints, &c. The isolation of an asylum practitioner; his exclusion from all means of maintaining a manual expertness in such practical arts as surgery or obstetrics—or such specialities as ocular or aural science: his devotion to his own peculiar duties, which consist largely of mere clerk's work, of drudgery of the most harassing and absorbing kind: the dissipation of his time and energies by administrative occupations, render it not only impossible that he can be *au courant* with modern progress in purely professional matters, but lead to the actual loss of his former ability or acquirements as a surgeon, an obstetrician, an oculist, aurist, or dentist. It is not, therefore, to be expected that, while perfecting his experience and ability as an alieniste, as an asylum physician, he should possess *all* the qualifications and discharge with equal efficiency all the functions of a surgical or obstetric operator. Nor, indeed, is it desirable, for many reasons and in many aspects of the question that he should do so. Especially in the case of female complaints, where manual palpation or visual inspection,—where the use of the speculum, or other vaginal or uterine appliances or instru-

Surgical emergencies, instruments, and appliances.

Obstetric assistance:

ments are called for, do we deem it *un*desirable that examination should be made, or treatment of a surgical nature carried out, by the resident medical staff. And yet there is every reason to believe that a large amount of nervous and cerebral irritation and disturbance in female patients results from remediable uterine disorders,—disorders requiring the use of the speculum, pessary, sound and bougie.

its value.

We hold strong convictions that such disorders are not attended to in hospitals for the insane to the extent that is desirable, on account of the obstacles to treatment by the resident medical staff; a state of things that admits of easy remedy by the occasional or regular assistance of obstetric experts. There is no reason why an hospital for the insane should not be on an equal footing with general hospitals in regard to the advantages of the periodical or occasional assistance of the most distinguished professional experts, in addition to the constant and regular services of a resident medical staff. In hospitals for the insane there are frequently, if not always, patients labouring under every form of physical disease; which physical disease in them is not only generally a source or cause of aggravation of the mental disorder, but is by the latter rendered all the more complex, insidious, and difficult of detection and treatment. Nor is it possible that either patients, their friends or the public can have equal confidence in an asylum physician as a alieniste, a surgeon, an accoucheur, a dentist, an oculist, and an aurist. At all events experience tells us that the best means of creating confidence and producing satisfaction in all emergencies not of the most ordinary kind is to confine ourselves to the strict duties of our department, and to hand over all difficult or unusual surgical cases to a skilful surgeon; uterine cases to an obstetrician; dental cases to a dentist, and other cases to their respective specialists.

Surgical operations or contingencies.

Practically during the last five years, it has seldom been necessary to call in extraneous *surgical* aid, the only kind of special professional assistance that has yet been had recourse to. But there have been several casualties, involving immediate or imminent danger to life, the majority of which unfortunately proved fatal, requiring the promptest and most vigorous treatment, demanding operative interference, or at some stage threatening to do so; in which the assistance of experienced surgeons from Perth was at once sought for and promptly afforded. Such causalties include several strangulated or complicated hernias; complicated hydrocele; fractures of the cranium, clavicle, &c.; acute laryngitis; articular and osseous caries; suspected dislocations or fractures; severe bruises leading to phlebitis; or other surgical injuries or affections of a serious character.

Co-operation of Surgeons and Physicians of Perth.

We would here acknowledge, with gratitude and pleasure, the skill and courtesy, the promptitude and attention of Drs Fraser Thomson and Christie, surgeons to the

City and County Infirmary, Perth, and of Drs Stirling and White, surgeon and physician in Perth respectively, in several anxious and dangerous or fatal cases in which their assistance was of most material or important service. We have not yet had occasion, nor deemed it expedient, to call in the assistance of the highest class of experts from Edinburgh or other University towns; but the permissive clause to which we have alluded imposes no restriction as to source, remuneration, or character of the extraneous surgical assistance of which we may deem it necessary to avail ourselves. This liberal and practically unlimited permissive power has been, and is, the source of very great comfort and satisfaction to us; experience, however, indicates that it should not be restricted to merely *surgical* or *medical* assistance, but *should embrace every species of professional aid.*

Contrast between system of Professional Experts and of "Consulting Medical Officers."

Five years' experience enables us confidently to assert that the modern plan of securing the services of scientific experts in cases of difficulty possesses great advantages over the old system, now universally being given up, of fixed and salaried consulting physicians or surgeons. Firstly, the modern system is infinitely more economical. The expert is paid the usual consultant fee, or such fee as seems proportionate to the nature of his special service. His assistance is required only in rare exceptional cases; hence the expenditure of a few guineas per annum represents the maximum average outlay. Under the old system the consulting medical officer drew a large salary for services, which were generally merely nominal, inasmuch as no emergency or difficulty really calling for aid or advice might happen in the course of a year.

Superior advantages of former system.

Secondly, it is infinitely more satisfactory to all parties,—to the Asylum authorities, the patients and their relatives or guardians, and the public alike. Under the modern system advantage is taken of the knowledge and experience of the highest authorities in the several departments of medicine and surgery; while under the old, the consulting medical officer was usually a general practitioner, specially skilled in no particular department of his profession, whose services in a difficulty, were too often more nominal than real.

Co-operation of Family medical attendants.

Another phase or aspect of this subject is, that we give every encouragement to the visits or consultations of the usual family medical attendants of patients, or of physicians or surgeons specially selected by their relatives or guardians.

Co-operation of Experts in legal cases.

A third class of cases occurs, involving questions at law affecting personal liberty, property, or wills, in which it is necessary to possess a variety of opinion as to the physical state, or bearings of disease, as well as to the sanity or insanity of the individual; and in certain cases of this class we have had the advantage of personal visits by, and the personal opinions of, all the highest authorities,—psychological, medical, surgical, obstetrical,—in Scotland.

Modernization of the Institution.

The Directors have ever been desirous that the Institution should be wanting in no modern appliances or appurtenances, in no conditions, advantages or possessions that can in any way or measure contribute to its efficiency as a curative hospital, or as a comfortable homely retreat for the insane of the middle classes; that can enable it to compete with the best institutions of its class, or with asylums, public or private of all kinds, throughout the kingdom. They have accordingly long had under contemplation certain classes of improvements or alterations, which are necessary to put an Institution, whose age exceeds by upwards of 10 years a quarter of a century, on a par with the most modern erections of its kind. It is their intention to fit it up in accordance with the views of the best authorities, with the

Contemplated alterations.

most recent advances in science; to supply it with the most approved products of modern art; in a word, thoroughly to modernise it by providing all the arrangements most suitable for its special ends or aims. Hitherto many of these alterations have been rendered impossible by the perennially over-crowded state of the building, which has put it out of our power to empty at any given time a whole gallery or department, so as to enable structural changes to be made, or even minor improvements, such as painting and papering, to be carried out. Not only would operations in densely crowded wards, occupied day and night, be annoying to the tradesman, who could not, under circumstances so unfavourable, be expected to produce the best class of work; but they would be dangerous, or sources of danger and irritation, to the patients, and on this ground alone they have been hitherto abstained from. The opening of the Murthly Asylum will, however, put an end to any further delay; and advantage will at once be taken of the reduction of our population to a minimum,—an opportunity that may never again occur,—by the exodus of our paupers, forthwith to carry out the repairs so necessary or desirable.

Alterations already executed.

There are, however, certain other classes of alterations, the carrying out whereof are not attended by the same difficulties; and improvements of this kind have been vigorously engaged in, or prosecuted, to the full extent of our opportunities and to the full limit of our finances. Annually a large proportion of the profits of the establishment, of the fund arising from the excess of revenue or income over expenditure, has been laid out on structural alterations or minor improvements; but the extent and nature of these alterations or improvements is necessarily limited by the amount of the available finances. Hence it is evident that every desirable or essential

Annual expenditure on improvements.

alteration cannot be made, or improvement added, at once; hence it becomes necessary to do one thing at a time, selecting that which appears for the moment most important. The past year has been

characterised by an unusual extent of structural and other alterations, mostly having a prospective reference to the future of the Institution, consequent on the removal of its pauper residents. The most important of these changes have occurred out of doors, in connection with the airing courts, pleasure-grounds, farm-yard, and out-houses; and these alone have necessitated an expenditure of between £500 and £1000. It is probably unnecessary for us to furnish the minutiæ of the improvements that have been made during the bygone year within or without the Institution; but it is perhaps desirable that we should give the items of those which, if not the most important, have been at least the most expensive.

Ventilating tower.

The unseemly ventilating shaft or tower to the north of the Institution, which, so far as concerns the purpose for which ostensibly it was originally erected, ventilation, has proved utterly useless and unnecessary, and which has served only as a monument of architectural folly and wasteful expenditure, has been taken down; and thereby a material obstacle to a beautiful, varied, and extensive view over the lower plains of the Tay, with the outstretch of the Grampians on either side of classic Dunkeld, and the Shakspeare-famed Birnam—has been removed.

Northern Airing Courts.

The two northern airing-courts, divided by the ventilating tower in question, whose high walls blocked up entirely, in relation at least to the lower northern galleries of the Institution,—the most densely peopled in the house,—the panorama above referred to; courts which, from the stagnation of air and moisture therein were, by the civil engineer employed to report as to their abolition, denominated, and truly denominated "Air-*tanks;*" which were not only useless, but were from their dark, sombre aspect and their unhealthy atmosphere, a positive sanitary nuisance to the lower departments of the north end of the building,—have been abolished. Their site has been converted into an open ornamental terrace, commanding a magnificent

Ornamental Terrace.

view, with a free healthy northern exposure. This terrace will be laid out with flower parterres and walks, and ornamented with statuary and vases; and it only requires a couple of ornamental fountains to render it one of the most attractive features or portions of our pleasure grounds. This alteration has exposed the northern aspect of the Institution in its lower departments, about which there is now a free circulation of light and air; and this has rendered necessary certain minor changes. Thus it has been desirable to alter the northern

Northern entrance door.

entrance, furnishing it with a new commodious stair-case. The windows of the rooms looking immediately out on the terrace referred to, which are mostly dormitories, will be provided with curtains, blinds, and other furnishings, or ornaments; and these will impart to this aspect of the house a more clothed and comfortable or homelike appearance than it at present possesses.

Western Airing Court.

The westmost airing-court, which has been practically nearly as useless and as noxious as the northern ones just alluded to, has for similar reasons been also abolished. We have a superabundance of airing-courts, which impart a certain prison-aspect to the main building as viewed from particular points; the disposition of the ground in this particular court is such that it afforded little view, while its high walls rendered it damp, dismal, and insalubrious; moreover, it was placed at such a distance from the Institution that it was impossible for attendants to exercise a due supervision over its occupants, when it was at all used as an airing-ground. The abolition of this court not only enables us to add a considerable area of hitherto useless space to the general garden ground; but it removes much of the prison appearance that has hitherto characterized the Institution as seen from the westward. It permits, moreover, a freer play of air and light on the west side of the building, and this is of itself a very decided sanitary advantage. The conversion of these northern and western airing-courts into free open spaces, has done much to improve the sanitary condition of the lower departments of the Institution, those occupied mainly by paupers, those wherein we have elsewhere shown * vitiated states of health, ailments or diseases, major and minor, when they occur at all, are three times as prevalent as in the higher portions of the house. And much will further be done to add to the dryness, warmth, lightness, and ventilation of these lower galleries by operations now in progress for draining more thoroughly than at present the ground immediately round the basement of the said galleries, and by introducing free channels for ventilation under their flooring and pavement.

Salubrity of Institution increased by removal of Airing-Court Walls, by Drainage, &c.

Farm-yard enclosure.

The farm yard—connected with the byres, stables, and piggeries, —which is situated contiguous to, and intersects a portion of, the main walk round the pleasure grounds, and which has hitherto presented an unseemly sight to the walking parties of patients, who are constantly passing and repassing it, has been enclosed by a substantial wall, provided with appropriate and convenient gate and doorways. This shuts in the farm yard department from the general grounds, and enables us, on the one hand, to keep together the farm-yard and other workers, and, on the other, to *exclude* mere passing walkers, and above all, the intermeddlers and muddlers,—the mischievous and prying—among the latter. It has enabled us to add to the amenities of other parts of the grounds by the removal of an unsightly ash-pit, or midden heap, and of equally unornamental masses or piles of cast-away slates, building stones, straw, gravel, hay, firewood, turnips, and lumber of all kinds.

* 34th Annual Report (1861), p. 45.

New Outhouses, Storehouses, and Workshops:

An extensive range of outhouses has been constructed with the stones resulting from the removal of the ventilating tower and the walls of the condemned airing-courts before referred to; these sheds or houses being provided with fire-places and appropriately lighted. They must prove of great value as supplying a species of accommodation, which is not to be found within the Institution itself, the want of which has been severely felt for years. We allude to storehouse accommodation for the garden department; for furniture not in use; and for the trunks, boxes, and other belongings of patients; as well as to workshop accommodation for artizans, such as painters, smiths, carpenters, shoemakers, tailors, or basketmakers. The purpose to which these outhouses will be more immediately applied will be that partly of storehouses, partly of workshops. But they are so arranged that, should occasion require or contingencies arise, they are susceptible of adaptation to several other important purposes. Their isolation from the main building, for instance, would render them most desirable as infirmary wards in the case of necessity arising for separating the affected during an epidemic; while, under more ordinary circumstances, they might form admirable additional dormitories. The possession of reserve accommodation of such a kind and to such an extent is an advantage of no minor importance; an addition by no means insignificant to the resources of the establishment.

contingent uses.

Greenhouse and Forcing Houses.

A greenhouse and conservatory, with relative forcing frames, potting house and other appurtenances have been erected in the garden at a cost of about £200. This is in itself an important acquisition and addition to the amenities of our pleasure-grounds; it is already filled with a tasteful array of showy flowers, and it has already become a favourite lounge of certain privileged classes of patients or individuals. But its principal use,—the object for which it was mainly constructed, —is to supply the galleries and parlours of the Institution with a constant succession, throughout the year, of ornamental shrubs or plants; to fill our Wardian cases and Ferneries; to furnish us with bouquets; to fill our vases. The experience of the past 10 years has shown us that there are few ornaments so useful and economical, so harmless and acceptable, so well calculated to awaken a love or admiration of nature's works, to bestow habits of orderliness and carefulness —as flowers. The gardener's tank or cistern, which has hitherto stood open at a corner of portion of the main walk round the grounds, and which presented inviting facilities for suicide by submersion, has been removed to the neighbourhood of the greenhouse, and covered with a secure iron grating. This removes all source of danger, while it does not impair the usefulness of the tank, which is represented as depending on the äeration of the water.

Ornamentation by Flowers.

Water-tank.

Industrial operations in Garden and Grounds.

The extensive changes in the grounds above recorded, have been, to a great extent, executed or effected by the patients, whose work has embraced taking down walls, wheeling rubbish and masons' materials, trenching ground, digging foundations and similar operations of a simple mechanical nature, involving, however, the expenditure of much muscular energy or force. In addition to these operations, the keep of the grounds of the Asylum and of Pitcullen, —the management of the pumps,—the care of the cows and pigs,—the laying out of new grounds and terraces,—the greenhouse, and all the ordinary out-door work have had to be attended to: and this has drained our galleries of all the able-bodied males capable of, and suitable for, this class of work,—who were not engaged in necessary in-door occupations; and have developed to the full extent the industrial resources of the male part of our community.

Improvement of Water-Closets.

Drainage operations.

Certain alterations have been made on the water-closets. Iron has been substituted for lead in the traps or drain pipes, with a view to prevent the frequent accidents hitherto arising from rupture and choking, and the escape and accumulation of night soil, or other noxious results therefrom accruing. Certain old ash-pits and cellars beneath the basement story of the building—immediately subjacent to the front or south lower galleries, are being abolished or closed, and their site or floors thoroughly drained. A thorough drainage is also being made of sundry damp airing-courts, in which, from the nature of the ground, water is apt to accumulate in wet weather. The whole drainage operations immediately above and formerly alluded to, will benefit more directly the lower or pauper departments of the building and will thereby materially add, it is expected, to their salubrity.

Additional and improved furnishings.

Matting and carpeting.

Kamptulicon.

Furniture.

Large additions have been made to the furnishings of the Institution in the shape of matting, carpeting, and upholstery. The whole of the lower or pauper galleries have been laid with broad, strong, cocoa-nut-fibre matting; while the bed-rooms, sick-rooms, and dormitories have been supplied with strips of carpet, all with a view to increase especially the winter comforts of the inmates, and enable them the better to resist noxious climatic or seasonal influences. *Kamptulicon* has been substituted for matting as an experimental measure in the higher galleries. But it is greatly more expensive than coir matting; the difficulties of laying it properly are much greater; while it does not impart the same feeling of warmth and comfort as matting, being more akin in this respect to wax-cloth. Several private parlours have been entirely refitted, painted, papered, and supplied with new carpeting and furniture. The use of wash-hand basins, supplied with crockery of the most modern kind, has been gradually extended throughout the house. Mirrors, towel rails, bags for combs and

Ornaments and decorations.

Wardian cases.

brushes, tooth and nail brushes, and other conveniences have been added, with a view to give a large proportion of the private bed-rooms the character of those of ordinary dwellings or homes. The higher classes of patients, especially the ladies, possess the perfumery and ornaments, which form the usual garnishing of their apartments in ordinary life. Wardrobes, clothes' presses, chests of drawers, or other conveniences for clothes are now to be found in most of the bed-rooms or dormitories for the higher classes of patients, and are gradually being extended to the lower departments of the house. Additional hangings, curtains and blinds are being supplied, especially to the pauper galleries and rooms; small bookcases are now to be met with in every gallery, parlour, or sitting-room; and the ordinary mantel-piece ornaments of private houses,—flower or match vases, gaudy shells, Parian statuettes,—are being introduced in all parts of the establishment. Important accessions have been made to our already large and varied supply of pictures, in the form of chromo-lithographs, especially of French production, engravings and photographs, all of the best class, intended for the further ornamentation of our galleries and parlours. The Murray gallery has been furnished with a large elegant Fernery or Wardian case, which has proved a material ornament; and further introductions of the same class of ornaments or furnishings will be made, as opportunity occurs, into every department of the Institution. Considerable expenditure has been made also on large ornamental flower vases for the decoration of the galleries in every part of the house; while additions are constantly being made to our stock of busts and statuary. The attendants are encouraged to make ornamental floral designs in suspended flower baskets, pots, bouquets, &c.; and several of them have attained great expertness and exhibited great taste in such displays.

Amenities of the Table.

Substitution of modern table furnishings.

In order to educate especially the pauper patients in habits of greater orderliness, cleanliness, and propriety at table, considerable changes have been made in the mode of serving meals; while the quality and quantity of the food itself, as well as the mode of cooking, have been, as will be subsequently explained, subjects of careful consideration and new arrangement. The whole of the old table furnishings and utensils in the pauper department of the Institution have been removed, and new furnishings of the most modern kind,—of a kind indeed in use by classes far above the rank of paupers in the social scale,—have been supplied. Knives and forks of the best kind are now in general use; German and nickel silver spoons have displaced those of horn; crockery and glass ware have taken the place of tin and pewter; table-cloths have been added in greater abundance, so as to secure frequent changes and a never-failing cleanliness. The proprieties of the table are further inculcated by every endeavour to seat the patients systematically before meals; by the presidency of one or more attendants at table; by the asking of blessings and other observances customary in private life. Our aims would further be assisted or carried out had we the means,—in the possession of retiring or ante-rooms,—vestibules fitted with lavatories, shoe-racks and presses for clothes, or other conveniences,—connected with commodious dining-halls or rooms,—to cause working patients to wash and dress before meals,—to change their heavy and dirty working boots for slippers,—to wash their hands and brush their hair, at least, before joining at table. Unfortunately, however, we are prevented carrying out reforms or changes of such a kind by the want of dining-halls with appropriate ante-rooms; by the greatly over-crowded state of our present unsuitable dining-rooms; and by the clumsy character of the furniture. The provision of a better class of dining accommodation and of a more modern and suitable class of dining-room furniture will, we trust, be one of the first fruits of the changes to be introduced immediately on the removal of our pauper population to Murthly.

Ante-rooms connected with Dining Halls.

The whole stock of cutlery and crockery,—of glass and other ware,—of table furnishings or appliances of every kind throughout the Institution has been replenished and modernised,—a better quality and larger quantity having been supplied for all classes of patients. Generally speaking the furnishings in question are of a superior kind to what the same class of patients would use in their own homes. While substantiality or durability have been aimed at on the one hand, elegance and beauty have been kept in view on the other:—acting on the conviction that important lessons may be taught,—important habits of thought, if not also of action, inculcated by the Æsthetics of "common things," no less than by the more pretentious Æsthetics of the picture or sculpture gallery.

Renovation of cutlery, crockery, glass-ware, &c.

Æsthetics of the Table.

The subjoined table indicates the present statistics of our staff of attendants and servants:—

Resident staff.

Males.	No.	Females.	No.
Gardener, ...	1	Head Cook, ...	1
Assistant Gardeners, ..	2	Under Cook, ...	1
Pump Superintendent, ...	1	Head Laundry-maid, ...	1
Head Attendant, ...	1	Under do., ...	1
Postman and Messenger, ...	1	Housemaids, ...	2
Tailor, ...	1	Workroom Superintendents, ..	2
Shoemaker, ...	1	Gallery Attendants, ...	5
Carpenter, (Fireman, &c.), ..	1		
Gallery Attendants, ...	6		
Total, . ..	15	Total, ...	13

Proportion of attendants to patients from 1 to 6, to 1 to 8.
Maximum, 1 to 5·75 [males]. Minimum, 1 to 8 [females].

Of these every person, male and female, has charge of patients to some extent or in some measure or form, save the postman and messenger. The supervision of the gardener and head attendant is less direct than that of the other classes of male attendants, in so far as these officers have under them various grades of assistants, who are immediately responsible for the patients under their charge. The artizan attendants and the gardener's assistants are occupied the greater part of each day in the workshops, grounds, or pump houses: all have patients in charge, though the number varies in each case,—the artizans having fewer in comparison than the garden assistants: all do, in addition, ordinary gallery work; they relieve the ordinary gallery attendants from time to time; and in every respect, save that their occupations remove them and their charges from the galleries during ordinary working hours, they are placed on the same footing as the gallery attendants. The same remark applies in spirit to the female attendants and servants, all of whom may be regarded, in certain respects and at certain times, ordinary gallery attendants. According as we *include* or *exclude* such officers as the gardener and head attendant from the calculation (from which, moreover, we exclude the postman and messenger, gatekeeper, or other officers not immediately in charge of, or responsible for, patients), the proportion of attendants to patients varies from one to six to one to eight,—the average being one to seven. This applies to both sexes and all classes of patients and attendants or servants; but it does *not* include special attendants for individual patients. We find it impossible to contrast this proportion with what obtains in other Scotch asylums, containing a mixed population, because in them (as their statistics are recorded in the third report of the Board of Lunacy for Scotland*) the item of special attendants for individual patients is not eliminated, and hence the data for comparison are not of equal value. Nor can we, from the same want of data of equal value in the two classes of cases, compare the proportion of attendants to patients in this Institution with that in private asylums or the lunatic departments of poor-houses and prisons. We have every reason for believing and asserting, however, that, in respect of the question under consideration, this Institution will be found to compare favourably with any institution for the insane, of what kind soever, in the kingdom. Our proportion of attendants necessarily varies with the predominant classes of patients. But,—leaving out of view special attendants for individual patients,—the number of attendants has probably been higher during the past year than at any former period,—in relation to the number of patients. This arises from the addition to our staff of supernumerary attendants in different departments of the Institution. Such addition has been rendered, or

Attendants and servants.

Nature & degree of supervision over patients.

Proportion of attendants to patients.

Supernumerary attendants.

* Page 261, Appendix G: Return of Attendants in Public Asylums.

Importance of ample staff of attendants.

deemed, desirable, mainly in order to enable us to exercise a more perfect and systematic supervision over certain groups of dangerous patients of the homicidal or suicidal class; to extend the facilities for open-air exercise and multiply our walking parties; to engage a larger proportion of able-bodied inmates in industrial, especially out of-door, occupations; to minister more efficiently to the sick, by providing the supervision of trustworthy hospital orderlies or nurses in special infirmaries or sick-rooms. Not only have these most desirable objects been fully realised or attained, but the possession of so ample a staff has proved an inestimable advantage to the establishment in an infinity of other forms. It is to this circumstance due that the interests of the patients have not suffered by the invaliding, sometimes for considerable periods, of several attendants of both sexes, or by the deaths of others: that we have been enabled to grant these invalids, without detriment to the Institution, the furlough of which they stood so much in need: that we are always ready to receive favourably reasonable applications for holiday leave, and that we annually grant a certain amount of such leave to every officer of every grade in the establishment: that we are prepared for all emergencies or contingencies,—such as sudden calls to send for, or accompany home, patients, —escapes or accidents.

Rewards to attendants for long or faithful service.

The Directors have ever been not only willing, but forward and ready, to reward appropriately the services of attendants and servants of every class, both in respect of the duration and quality of these services. The form of reward or award differs in every individual case; and it frequently assumes some more graceful, exceptional, and unusual guise than a mere increase of wages or addition to emoluments, though the latter is assuredly by no means the least substantial or satisfactory of the said forms or guises. The most gratifying feature of such rewards perhaps consists in this,—that, recognizing to the full, and accordingly acting on, the principle that the "labourer is worthy of his hire," and the diligent, faithful servitor,—the tried and attached servant of much more than mere hire,—the Directors do not *wait to be asked or importuned* for the recompense supposed to be commensurate with the deserts of the applicant; but they offer and urge their rewards when and where they are unexpected and unsolicited, selecting such form thereof as may be expected to be most acceptable to the recipient or his friends. During the past year these rewards have been of an unusually varied character or form; and we give them this publicity less for the gratification of the recipients themselves or their representatives (alas! that some, to whom honour was intended and honour was due, are far beyond the reach of any praises of ours!) than for the encouragement of their compeers and successors,—as a stimulus to *them*

Spontaneity of Reward.

likewise to devote their whole energies to the faithful discharge of their responsible and delicate duties.

Excursion to Exhibition of 1862.

In the case of 2 attendants, who have been attached to the service of the Institution for the periods respectively of 35 and 30 years, and whose long and zealous services have, moreover, been repeatedly crowned with other honours, the approbation of the Directors was marked by sending them, with a fortnight's leave of absence and all expenses paid, to the Great Exhibition in London,—one of the excursionists not having been previously furth of Scotland. In that of another attendant, who died in the Institution in the flower of his youth, the Directors indicated their sense of the value of his services by taking upon themselves all the expenses and the arrangements of the funeral, besides showing other marks of respect to his memory; while, in that of a third, they provided what was most appropriate under the circumstances at the time,—a gift of an ample and handsome mourning suit. The peculiar circumstances or conditions of the two last mentioned awards are recorded in the columns of our "Excelsior," and need not therefore be here repeated or reproduced. In sundry other cases—for special service—such as precenting at Chapel—money gifts have been bestowed.

Honours to the Dead.

Premiums for special service.

Superannuation allowance:

In one case the form of reward was the very substantial one of a Superannuation allowance, with concomitant privileges. This was equivalent to retiral on full pay, with the additional advantage of board, lodging, and other allowances. The officer on whom this important reward was bestowed—one which we have great pleasure in adding he fully merits—is upwards of 70 years of age, and has spent the better part of his long and useful, inoffensive, blameless life,—upwards of 35 years,—in the service of the Institution. He has unfailingly proved a most efficient, exemplary, and trustworthy officer; and his desire to continue to promote the interests of the Institution by any form or degree of service in his power is only limited by his failing physical vigour. Under ordinary circumstances an annuity or pension would at once have been granted by the Directors; the officer so pensioned would have been relieved from office; and he would have been permitted, as well as expected, to reside beyond the precincts of the Asylum. But so strong is the attachment to, and affection for, the Institution in this aged officer, who combines in himself the characteristics of a "Caleb Balderston" and a "Nathanael," that he made it the subject of special petition to be allowed to "end his days" therein, and he expressed himself ready to "die in harness," provided he were not expelled, or removed, from what he had long regarded as his home, and which was really the only home he had, for he had long

Its reasons and peculiarities.

Attachment of old officers to the Institution.

since buried in the silent grave the affections and memories of his earlier years. On being informed of the disposition, on the part of the Asylum authorities, to furnish him with the means of comfortably retiring and nursing his old age, he expressed only the desire that he should be permitted, if possible, to continue his present quarters and his present fare in the Institution, deeming *that* prize and reward abundant for all his long and faithful service. It afterwards appeared, indeed, that he had long been in dread of the suggestion of superannuation, in the belief that this would necessarily imply a residence elsewhere; and this fear had prevented, on his side, the expression of the slightest desire of relief from toil,—of a superannuation allowance or privilege of any kind; and had inspired the determination to struggle in office to the last, and to die therein rather than surrender the privilege he so much valued of residence in the Asylum building. Taking into consideration all the features of the case, the Directors at once permitted a continuance of his present residence, board, and other household privileges, and a continuance, moreover, for life of his present full pay; while they relieved him from all office or duty save such as is optional or self-imposed, or such as, in our opinion, may be suitable for his years and abilities. He enjoys, therefore, for life all his present or former emoluments and advantages; while he is relieved of all cares and responsibilities save such as are self-assumed. In point of fact, he finds it indispensable to any enjoyment of existence that he discharge a certain amount of "duty;" he remarks most truly that having "nothing to do" would bring him to his grave; and he accordingly acts with continued acceptance as postman and messenger,—at least during the spring, summer, and autumn months.

Provision for securing a high class of Attendants.

We would gladly, did space permit, make this case a text, wherefrom to remark at length on the means of securing for the future a high class of asylum officials, especially of the lower grades: a subject whereon we do not now remark for the first time, nor perhaps the last. Without permitting ourselves to go here, or at present, into detail, we would simply indicate the following as the chief means or measures necessary, in our estimation, for securing an end so desirable:—

Increased wages.

1. A raising of the fixed minimum rate of wages.

Proportional advancement.

2. A sliding scale of increase of wages—a progressive annual addition—proportioned to length and quality of service.

Premiums for special service.

3. Special and additional awards or premiums—in money—for special service or qualifications: such as conspicuous success in
   a. Minimising the number of
      1. Accidents, assaults and quarrels: of the refractory or turbulent.

      2. The dirty and degraded.
   b. Detecting and checking vicious habits or propensities.
   c. Promoting cleanliness and tidiness of dress, and furniture.
   d. Introducing, promoting and rendering popular games, amusements and occupations.
   e. Maximising industrial occupations and their fruits.
   f. Promoting a love of beauty and order by the most tasteful arrangement of flowers, pictures, statuettes, ornaments.
   g. Exercising forbearance and self-control under circumstances of unusual irritation and provocation.
   h. Night watching, or tending the sick or feeble.
   i. Precenting at Chapel, or otherwise presiding at Re-unions of any kind.

Superannuation.

4. Superannuation allowances, or retiring pensions on a liberal and equitable scale: their nature and amount being proportioned not only to the *duration*, but to the *quality*, of the services of the officers to be superannuated.

Competition for trained officers.

Some such inducements, we believe, are absolutely indispensable or necessary to permanently attach to an asylum, officers, especially of the subordinate grades, of the most suitable kind, and to prevent the present liability to constant change,—for instance among the attendants,—change which directly operates most deleteriously, in multiform ways, on the best interests of the patients. Some such inducements, moreover, are daily being rendered more desirable by the increasing competition for trained attendants on the insane, in consequence of the springing up in all directions of county or district asylums, the extension of the lunatic wards of poor-houses and prisons, and the multiplication of private institutions for the insane. We cordially concur in the remarks of the Commissioners in Lunacy for Scotland* on the inadequate remuneration of asylum attendants. They allude to the "rate of wages paid to attendants as being on too low a scale to retain "the permanent services of trustworthy and efficient persons:" and they go on to remark "the importance of this question cannot be "overstated; for it is upon the quality of the attendance, more than "upon any other element, that the comfort and wellbeing of the patients "depend. But, until the amount of their remuneration is so increased "as to make the loss of their situations a matter of consequence to the "attendants and to their families, the patients will be deprived of perhaps the greatest safeguard against neglect and cruel treatment that "can be provided. To those private patients, who have been accustomed to respect and obedience in their own houses, it is more especially galling to be subjected to the control, and it may be, to the

Inadequate remuneration of Attendants.

* Fourth Annual Report: Edin. 1862. Page 59.

"tyranny of coarse and uneducated men, whom formerly they would "have rejected as domestic servants."

Superannuation allowance:

their necessity and advantages.

Of all the provisions or classes of inducements to which we have abovereferred, Superannuation Allowances appear of greatest importance. We find that entrants on asylum duties consult less their *present* advantages than what they term their *prospects*—their opportunities of advancement or promotion, such promotion carrying with it as is naturally expected, and as it undoubtedly should, extra pay or additional emoluments; above all, they look to the provision they may be enabled to make, or that may by their employers or patrons be made, for their old age, or for sickness and other sources or causes of incapacity. And it is in respect of these prospects, these *future* provisions for the well-being of its officers, that the Scotch asylum service stands at a great disadvantage when compared with other departments of the civil service certainly not more worthy nor important, or with the naval or military services. It is a curious anomaly that, while the most recent statutes affecting asylums in the sister kingdoms make provision for superannuation allowances to all classes or grades of asylum officers; while in England and Ireland these officers are placed, so far as regards superannuation and other advantages or privileges, on equal footing with the officers in other departments of the civil service: in none of the Scotch Lunacy statutes do superannuation clauses occur—on none of the officers in Scotch asylums are such rewards by law bestowed. We cannot conceive any adequate or proper reason why Scotland should, in this respect, occupy a position so peculiar and exceptional; the more exceptional and peculiar if we extend our comparison and regard the corresponding practice of continental countries, such as Denmark. It cannot be that the asylums of Scotland are less worthy than those of the sister kingdoms. Indeed we might with propriety,—though deprecating any form of another "justice to Scotland" agitation, maintain the converse, and assert that, in so far as the Scotch asylums are, as a whole, older, and have done more public service,—omitting all reference to the comparative quality or nature of that service,—than those of England or Ireland, they are more worthy of the possession of advantages, such as must accrue from superannuation allowances to their officers. The Royal chartered asylums of Scotland are now of comparative age (their precise respective ages from the date of opening being Montrose 81 years; Aberdeen 62; Edinburgh 50; Glasgow 49; Dundee 43; Perth 36; Dumfries 24); they have been altogether or mainly originated and conducted by private or public enterprise,—without government assistance, perhaps in spite of government apathy; and it

Comparison of Scotch with English and Irish Asylum service.

Defects of Scotch Lunacy statutes.

Asylum-service a department of the Public Civil Service.

is infinitely to their credit that they have done so, and done so to such effect. But the Scotch Asylums Act of 1857 placed all of them under government supervision; imposed on all certain government regulations; *pro tanto* converted them into government institutions; and as such gave them a claim, we think, in addition to many other claims or considerations, to be regarded as departments of the civil service of the country. We at once admit there must be difficulties in the way of regulating, on a uniform basis, superannuation in the older Chartered, equally with the new District, asylums of Scotland. Nor do we propose interfering with this aspect of the question; which we prefer leaving for adjustment to and by the Commissioners in Lunacy for Scotland and the authorities of the respective asylums. But we may be permitted to express a fervent hope that no material obstacle may ultimately interfere with placing all classes of officers in the Scotch asylums on an equal footing, as regards superannuation, with their more fortunate brethren in England and Ireland.

Extension of Superannuation advantages to Scotch Asylums.

In several English Lunacy Statutes* occur provisions of a liberal kind—though not so liberal as we hope to see before long in equivalent statutes in Scotland—for the superannuation of all classes of officers in the public asylum service. These officers in England have virtually all the advantages arising under the Superannuation Act of 1857, which applies to all departments of the modern civil service, including the English Lunacy and Prison Boards, and to all classes or grades of officers from clerks upwards; as well as under the older act, 4 and 5 William IV., which regulates "the Pensions, compensations and "allowances to be made to persons in respect of their having held civil "offices in His Majesty's service."

Superannuation in English Asylums.

Ireland is even better provided, inasmuch as it is fortunate enough to possess a special "*Superannuation Act*" applicable to public asylums.† The act in question has been in successful operation for several years. In the latest Irish Asylum Report, which has reached us,—that of the Richmond District Asylum, Dublin, (for 1862),—the superintendent gives an illustration of the ordinary working of the act in the superannuation of a female attendant, aged 42, whose period of service had extended to 24 years,—whose wages had been £8 per annum, with allowances equivalent in value to an additional annual sum of £28, and who was superannuated on an annuity or pension of £15, 2s 4d. The same superintendent in the same Report (page 28) gives it as the result of his experience, that "The application of the Superannuation "Act to the staff at Lunatic Asylums . . . . . . is a measure "*not only of justice to the recipients, but of advantage to these institu-*"*tions.*" Testimony still stronger is given by Dr Nugent, Commis-

Superannuation in Irish Asylums.

Successful operation of "Superannuation Act" in Ireland.

* 1. 16 and 17 Vict. cap. 97, sect. 57, 1853, which regulates the County Pauper Asylums of England.

2. 25 and 26 Vict. cap. 3, sects. 12 and 73, 7th August, 1862 ("Lunacy Acts Amendment Act, 1862.")

3. 25 and 26 Vict. cap. 86, sect. 26 ("Lunacy Regulation Act, 1862," 7th August).

† 19 and 20 Vict., cap 99 ("The Lunatic Asylums, Superannuations, Ireland, Act 1856:" otherwise "An act to amend the acts relating to Lunatic Asylums in Ireland so far as relates to Superannuation,") 29th July, 1856.

sioner in Lunacy for Ireland,* who speaks in the highest terms of the benefits conferred by the Irish Asylums Superannuation Act. Referring to sundry asylum officers, who had retired on the "liberal pension"

Justice and policy of Superannuation.

provided by the said act, he goes to say: "That provision should "be made for the officers of District asylums, as elsewhere, when worn "out by age and length of service, is but just and reasonable, and "on principle has been ever advocated by us. We know no duties "so onerous and so unceasing as those connected with the management "of the insane, entailing at all hours the same anxious responsibility. "As the labourer is worthy of his hire, a liberal recompense when "engaged on service, and *the certainty of a commensurate allowance* "*on retirement*, is but a reasonable expectation: and we cannot but

Opinion of Commissioners in Lunacy for Ireland.

"think that the staff of lunatic asylums in this country, as a body, "are not only underpaid when on duty, but that an exceptional rule "should be made in favour of deserving officers, who, growing old in "them, are rendered unfit for after employments by previous "habits, professional or other. Take, for example, the medical super-"intendents, restricted to a sort of cloister life within the precincts of "an asylum—men of education, enlightened views and varied acquire-"ments—their hours devoted to the good of the helpless and afflicted, "and compare their salaries with those paid to the members of other "professions, who are certainly not superior in knowledge, and whose "sphere of action, though useful and necessary for the well-being of "society, is not directed to the attainment of a higher or more important "object than that of the individual, who labours to ameliorate the "condition of his fellow-creatures under the heaviest and most dreaded "visitation to which mankind is liable."

Revision of Dietaries.

We have lately revised, by the light of recent advances in Chemistry and Physiology in their bearings on Dietetics—all classes of the Dietaries of this Institution—with a view, where necessary or expedient, to alter or amend them With the same end in view we have endeavoured to institute contrasts or comparisons, in respect of their nutritive value and suitableness, between these dietaries, and those not only of other institutions of a similar kind in all parts of the world, but of general hospitals and the public services, as well as all other dietaries of a comparable class, or that might yield data of any service in our investigations. At the very outset of our inquiries, however,

Unsatisfactory form of Public Dietary Tables.

an almost insuperable difficulty presented itself in the form in which public dietary tables are generally drawn up. So much does this form vary—so great, further, are the differences in the constituent items of public dietaries—that we found comparison of an accurate or useful kind simply impossible. In order to ascertain how far our dietaries

* 8th "Report of the District, Criminal and Private Lunatic Asylums in Ireland," 1857. Page 14.

come up to the standards laid down by the most recent and best authorities on the chemistry and physiology of food—to the physiological requirements of the adult healthy system under varying circumstances of occupation and exercise—it appeared indispensable to

Estimates of Nutritive value.

determine their nutritive value by estimating the mean daily allowance in dry or solid nutriment per person they respectively represent. The only accurate and satisfactory means of arriving at such a result is by chemical analysis of all the constituent articles or items of our dietaries, and by calculations based thereon in reference to the number of the consumers. Such a procedure would, however, require the services of a professional analyst, and would entail not only a heavy expense, but great labour and considerable delay. Nor is this necessary or essential to our immediate purpose: for, *approximative* results of sufficient accuracy for present ends may be arrived at by using, as a basis for calculation, the chemical analyses of different quali-

Chemical analyses of Foods.

ties of ordinary food made in this and other countries by various of our most distinguished chemists, experimental physiologists, or authorities on dietetics, within the last quarter of a century, and especially during the last few years. These analyses have been diligently collected, compiled, and tabulated—and the means, or average results, exhibited—by various recent writers and experimenters on dietetics: the tables so arranged are now generally regarded and received

Tables showing Solid Nutriment in Foods.

as standard scales for estimating the amount of dry nutriment in, or, in other words, the nutritive value of, our ordinary food. None of these tables are, however, of such a character as to be alone, or in themselves, serviceable for our purpose. Compared with each other for the purpose of selecting the best or most trustworthy, they exhibit marked differences or discrepancies in their estimates—depending mainly, perhaps, on differences in the mode or object of the chemical analyses, as well as on the different qualities of the representative or

Differences in chemical analyses and estimates.

typical articles analysed. Generally speaking, the older analyses may be looked upon with some suspicion. So rapid has been the recent growth or progress of organic chemistry; so striking the changes in systems of analysis; so numerous and important the improvements in its instruments and appliances; so greatly have analytical chemists been multiplied, and so much more expert have they become—so much greater exactitude has characterised their results—that the same articles of food give, in the hands of modern chemists, results very different from those published by their predecessors or represen-

Errors of older analyses.

tatives even 10 years ago. The older chemists seem to us to err, for instance, in their excessive estimates of the proportion, or per centage, of the *nitrogenous* constituents of food.

Standard Table of Solid Nutriment in Foods.

Considering the differences and discrepancies in analytical results, to which we have alluded, we have deemed it desirable, if not necessary, to construct for ourselves a Standard Table, showing the proportion of solid or dry nutriment in various common foods: which table we may use as a scale or basis for calculating or estimating the nutritive value of the Dietaries of this Institution, as well as of certain other dietaries, with which we institute comparisons. Our table is based on the means or averages of the best tables or statistics of the same class hitherto published: those, especially, which have been drawn up or published by

1. Professor Parkes[1] of London.
2. Professor Lyon Playfair[2] } of Edinburgh.
3. Professor Christison[3] }
4. Professor Haughton[4] of Dublin.

The Standard Table so constructed and hereto immediately appended,—which forms the basis of all the tables and calculations relating to dietaries or foods that are to follow,—in so far as these are

1. Professor of Hygiene, Dietetics, &c., in the Army Medical College, Netley: a *MSS.* table, being that used in his courses of Lectures to Army Assistant Surgeons; for which table, and for its compiler's courtesy in supplying it and explanatory notes, we have to record our grateful acknowledgements. This table exhibits the means of analyses of average food—similar to soldier's food—by continental chemists especially—including Von Bibra, Poggiale, and others; as well as by Lawes and Gilbert, and other British authorities. It gives separate estimates of the two great classes of *Carbo-hydrates*, which constitute the heat-giving section of the constituents of food; the fats and oils on the one hand, and the starches and sugars, dextrine, &c., on the other. The calculations would appear to be based on *raw* food, which renders it necessary that certain deductions be made for *loss by cooking*. It may save repetition if we here add, by way of illustration, in regard to meat as supplied by the butcher, that the average deduction for bone amounts to 25 per cent., while the *loss of weight by cooking* amounts to from 30 to 35 per cent.; so that the allowance of cooked meat *free from bone*—the quantity, in other words, suitable for digestion—falls to about one-half only of its weight when uncooked or raw.

2. Professor of Chemistry in the University of Edinburgh. Table of the "Constituents of Food"—the result mainly of original analyses—given in "Popular Lectures on Food," delivered at the South Kensington Museum [London, 1861], by Dr Lankester, Superintendent of the Food collection at South Kensington, and Coroner for Middlesex. This Table is characterised chiefly by its separate determination of the *Salts* or mineral constituents of food, which, in such estimates or tables, are generally omitted.

3. Professor of Dietetics and Materia Medica in the University of Edinburgh. Printed tables used in the said course of Lectures in November, 1849. A marked feature of these tables, in comparison with similar ones of more recent date, is their *high* estimate of the *nitrogenous* constituents of food. For instance, these constituents are given in:—

Meat—at from	20·25 to 27 per cent.
White Fish, ...	21 "
Bread, ...	10·5 "
Wheaten Flour, ...	16·25 "
Butter Milk, ...	6.60 "

There appears to be associated a comparatively low estimate of the *carboniferous* constituents in certain articles of diet; which are stated, for instance, in:—

Meat—at	15 per cent.
Oatmeal, ...	65.75 "
Barleymeal, ...	67.00 "
Butter Milk, ...	1·00 "

while no separate estimate is formed of the *Salts* or mineral components of food.

4. Tables of results given in the undernoted Pamphlets or publications, for which we have to offer our thanks to their author:—

a. "On the Natural Constants of the healthy Urine of man, and a theory of work founded thereon:" Dublin Quarterly Journal of Medical Science: Aug. 1859: Aug. 1860: and Nov. 1862.

b. "On the phenomena of Diabetes mellitus:" *Ibid.* 1861.

The results are those of actual experiment by the best methods known to modern science, and of analyses of the most rigidly accurate kind. So far as they go, they are among the most trustworthy and admirable with which we are acquainted. But their limited range, and the object and character of the analyses render these results unsuited, for the most part, for our present calculations and comparisons.

not the productions of other authors, and distinctly so specified—requires certain explanations in order to its due understanding and use.

STANDARD TABLE—BASED ON THE CHEMICAL COMPOSITION OF FOODS:

being a Scale for estimating the Nutritive value of the Principal articles of ordinary Diet.

Standard Table of Solid Nutriment in Foods.

	Per Centage of Dry or Solid Nutriment.				Water.
	Nitrogenous (1)	Carboniferous (2)	Mineral ¶	Total Solid Nutriment.	
1. Meat—*a.* —Butcher meat—(Beef, Mutton, Pork, Veal, Lamb:—fresh — raw or cooked—lean, or with moderate proportion of bone and fat),	15	23	1†	39	61
b.—Fish—white—(Herring, Haddock, Flounder),	15	6	1	22	78
c.—Bacon and Pork Ham,	9	57	1	67	33
2. Bread — white or wheaten — best and average qualities,	8	50	2	60	40
3. Wheaten Flour—best and average,	14	70	1	85	15
4. Oatmeal—best and average, ..	17	68	3	88	12
5. Barley—(Pearl—barley meal or flour), ...	14	70	2	86	14
6. Indian Corn (or meal—Maize),	12	72	1	85	15
7. Rice, ...	6	87	1	94	6
8. Sago, Arrow Root, and Tapioca,	4	82	1	87	13
Mean of the two foregoing classes of Farinaceous foods, ..	5	84	1	90	10
9. Eggs, ...	13	12	—	25	75
10. Milk—sweet and skimmed—sp. gr. 1025 to 1035, ...	4	7	1	12	88
11. Cheese, ...	48	25	5	78	22
12. Butter—salt and fresh, ..	—	95	—*	95	5
13. Fat, Suet, and Lard, ...	—	100	—	100	—
14. Potatoes	2	24	1	27	73
15. Peas—dry—split, —	24	56	3	83	17
16. Do. green, ...	7	36	2	45	55
17. Carrot, ...	2	9	1	12	88
18. Turnip, ...	2	5	1	8	92
19. Cabbage (fresh or boiled), ..	2	6	1	9	91
Mean of the 4 foregoing classes of Vegetables— Miscellaneous Vegetables—(including Pot vegetables—Greens (Kale), Onions, Leeks, Cauliflower, Brocoli, Brussels - Sprouts: and Salads—Asparagus, Lettuce, Beetroot)—are calculated on this scale, ... 20. Fruit—(including Rhubarb, Apples, Pears, Plums, Strawberries, Gooseberries, Raspberries, Blackberries, and Currants,—are also calculated on this scale,	3	14	1	18	82
21. Sugar, ...	—	98	—	98	2
22. Cocoa (nibs—Chocolate), ..	22	69	4	95	5

* Exclusive of the *Salt* used in curing.

† — — *Nitre*, &c. used in pickling.

¶ Quantities below 1 per cent omitted—for convenience in calculation: *Salts*, (such as common Salt), used as condiments, also necessarily omitted.

1. Including albumen, fibrine, caseine, and gelatine, and their equivalents in the vegetable series.

2. — oils and fats; sugars and starches; gum and cellulose (or woody fibre); and dextrine.

Nitrogenous constituents of Foods.

The first column represents the proportion in food of what are variously denominated, according to the chemical or physiological views of authors, their nitrogenous, sanguigenous, plastic, or tissue-forming elements or constituents. This group of components is alone capable of being transformed into blood, from which all the animal tissues are formed*—can alone supply, by new plastic materials, the fabric-waste of the body. It consists of the albuminous series of substances respectively denominated albumen (their type), fibrine, caseine, and gelatine, characterised by *nitrogen* and sulphur, more especially the former, as integral elements of their chemical composition. Hence the proportion of these substances in food is generally sought to be ascertained or estimated by the percentage of nitrogen the food in question contains. Sanguigenous substances further contain, as essential ingredients, certain small, but never absent, proportions of *salts or mineral matter;* alkalis especially, and alkaline or earthy phosphates.

Not necessarily nutritious.

All the members of this group of substances—the nitrogenous constituents of food—are not nutritious, according to the most recent experimentalists, in the sense that they directly add to the repair of waste, to the building up the fabric of the animal body. *Gelatine,* at least, appears to be an exception; but there is yet no good ground for refusing to believe that this substance nevertheless subserves some useful purpose as yet unknown, in digestion—in the economy.

Physiological action of Foods.

Indeed, the *modus operandi* of food in nutrition, notwithstanding the rapid progress that has recently characterised experimental physiology and chemistry in their applications to dietetics, cannot yet be said to be accurately or satisfactorily known or determined. There are various substances and classes of substances, of which science tells us that they do not contribute to nutrition, in the sense either of supplying tissue-waste, or maintaining animal heat, of which, nevertheless, experience tells us they do, in some way, minister to digestion and assimilation,

Science and experience at variance in selection of Foods.

in the sense at least, that they prove valuable or indispensable adjuncts or aids to the chemical and physiological action of other substances, concerning the nutritive powers whereof there is no doubt. This is a case where experience is at variance with scientific theory or abstract science, and where the former is probably a safer monitor or guide than the latter. Science pronounces gelatine to be non-nutritious in the strict sense of the term "*nutritious,*" and hence would expunge this nevertheless useful substance from the category of *Foods.* Experience, on the other hand, indicates that there is a universal craving for gelatine in some form as an ingredient in foods; and that, so far from being deleterious or innutritious in the popular sense, it ministers pleasantly to digestion and assimilation in some way, whatever science may say

* Muscle, or flesh, says Gregory, is "simply Blood more highly organised." Handbook of Organic Chemistry, 4th edition: Edinburgh, 1856. Page 53[illegible].

to the contrary. The statement by the best and most recent authority on the physiology of food, one of our ablest experimental physiologists, Dr Edward Smith—that "Appetite for food is the expression not "only of *desire* but of *fitness,*" referring to particular articles or ingredients of food, has a distinct bearing on the point at issue.

Appetite as a guide to selection of Foods.

Carboniferous constituents of Foods.

The second column of the standard table represents what are variously denominated by chemists or physiologists according to the view adopted of their action or composition—carboniferous, carbonaceous, respiratory, heat-giving or calorifacient components of food. These substances evolve or supply, by or in course of their oxidation, the animal heat; but they do not contribute to the building up of tissue or fabric, save insofar as fat or oil is necessary thereto. They are otherwise termed carbo-hydrates; but they are less distinguished chemically by the possession of *carbon* and *hydrogen,* as essential elements of their composition, than by their differing from the nitrogenous, or previous, group by the non-possession or absence of nitrogen and sulphur.

Classification of Carbo-hydrates.

They embrace two great classes of substances:—1, That which includes oils, fats, and butter; and 2, that comprising starch and sugar, dextrine, gum, and cellulose. This group, as well as the former one,—the carboniferous as well as the nitrogenous constituents of food, as tabulated above, and as generally tabulated for the purposes of calculations of a similar kind,—contain certain substances not in themselves nutritious, directly or in a strict sense, but which are, notwithstanding, important aids to the digestion of the truly nutritious components with which they are usually associated in ordinary food.

Not necessarily nutritious.

Such substances are gum and cellulose or woody fibre, as contained in the husks of the farinacea, and in the tissues of green vegetables. But these matters are of such undoubted service as stimulants of the peristaltic action and of the secretions of the intestines, especially in persons of sedentary habits and passive life, that it is generally necessary or advisable to add to ordinary food,—of a more strictly nutritious and digestible kind,—a certain proportion of avowedly *indigestible* material of the class in question. Hence it is by no means desirable that certain foods, such as bread, should be of *too fine or pure a quality:* hence the superiority of brown bread and a varied vegetable diet including fruits, over diets from which these substances, or their equivalents, are absent: hence the benefit of the use of bran biscuits and similar articles as adjuncts or additions to the too fine bread in use by the upper ranks in this country.

Mechanical quality of Foods.

Mineral constituents of Foods.

The third column of the table contains, or sets forth, the proportion of the saline or mineral constituents of food, which, though usually existing only in small quantity, are still indispensable to true nutrition, to the supply of waste, to the repair or replacement of old tissue, to the formation of new. The salts in question are chiefly the phosphates, carbonates, sulphates, fluorides, and chlorides of lime, soda, potash, magnesia, and iron, which are necessary more especially for building up the solid framework of the body. Phosphates and lime are indispensable to the construction of bone; iron and soda to the composition of the blood; potash occurs invariably in the juice of flesh; and chlorine in the gastric juice. No estimation of the nutritive value of foods can be complete in which the salts thereof are omitted; at the same time they exist in so minute quantities that it is generally unnecessary to form a separate estimate. In the tables based on our standard table no separate estimate has been given; but the salts have been associated with the carboniferous constituents, not as more closely allied thereto than to the nitrogenous, but simply as an arrangement of greater convenience.

Total solid Nutriment in Foods.

The 4th column of the Standard Table gives the aggregate of the preceding 3 columns,—the total solid nutriment in foods; and the 5th column is introduced simply as complementary to the 4th,—these 2 columns representing in total the chemical composition of Foods. We make, however, no separate estimate of the water in foods in the calculations based on this table, because the nutritive power or value of foods depends on their *solid* constituents, and is generally inversely in proportion to the quantity of *water* they contain. Besides, the estimation of water is at all times easy and simple, by deducting the per centage of solid nutriment from 100 parts of any given food.

Water in Foods.

Chemical classification of constituents of Foods.

We have employed the classification of the components of foods generally used by scientific authorities, without thereby attaching ourselves to Liebig's celebrated "Theory of Food," on which perhaps such classification is mainly founded. It would appear indeed, from the most recent researches,* that this ingenious and popular theory has been tested by rigid science, and found wanting, in so far as, *inter alia*, while the so-called calorifacient or non-nitrogenous group of foods, or the constituents thereof, cannot build up, or replace, tissue, the nitrogenous or plastic group can both generate and maintain animal heat, and supply tissue-waste. This is not surprising when we call to mind the chemical composition of the latter group; how while characterised by elements (nitrogen and sulphur) absent from the other group or class in question, they possess in common the important elements carbon, hydrogen, and oxygen—and are *pro tanto*, as much as the calorifacients proper, carbo-hydrates, susceptible of an oxidation attended with the evolution of heat.

Liebig's "Theory of Food."

Nitrogenous substances as calorifacients.

It is further necessary to explain that all our tables and calcula-

* "Experiments on Food; its destination and uses," by Professor W. Savory; read before the Royal Society of London, May, 1862. *Lancet*, April 4 and 11, 1863. *Vide* also the Researches of Bischoff and Voit, &c.

tions refer to *Foods proper;* Foods necessary; Foods for the most part solid; Foods more strictly nutritive, ministering directly to tissue-repair, or calorifaction. Hence no reference is made to such beverages or substances as tea and coffee, beer and porter, wines and spirits—some of which are constant ingredients of ordinary diets; but which belong to the class of dietetic medicines or medicinal beverages, a class intermediate in character between Foods proper and Medicines proper. As such we prefer considering them separately and in equal detail on some future occasion. No considerations on the Physiology of Foods can be complete, however, where no account is taken of the part played by the large and important class of neurine stimulants or calmatives. We believe their *modus operandi* on the human system to be still *sub judice;* but all our experience goes to indicate that, in certain classes of cases, in a large proportion of mankind, in society as at present constituted, their benefit is undoubted. This being the case, we have ever felt it unjust and cowardly to permit any prevalent popular views, or any mere scientific aspects of the question of their physiology or chemistry, to deter our commending or prescribing in this Institution substances, which, whether regarded as "Food, Medicine, or Poison," are, *when rightly administered, of unquestionable service.* Nor do we take in our Tables any note of condiments, such as salt, mustard, pepper, vinegar,—though some of them are (for instance, salt) indispensable to nutrition, or prove valuable adjuncts to the healthy action of Foods as generally used by mankind. Their consideration would lead us into another wide field of inquiry. Of their utility the universal testimony of our race, civilised and savage, leaves no doubt; they supply perhaps "besides stimulation, some elements cunningly "suited to the constitution of mankind." *

Foods proper in contradistinction to Dietetic Medicines.

Physiological action of Dietetic Medicines:

and of condiments.

Using the Standard Table or scale already given as a basis for our calculations, we have drawn up a series of Tables showing the amount of dry nutriment in,—or in other words the nutritive value of,—the typical classes of the Dietaries of this Institution. We have generally selected *male* dietaries deeming it unnecessary to encumber our space with those for *females*, which differ only in so far as they exhibit a certain reduction or deduction in certain articles of Food. This deduction amounts on an average, to from 10 to 20 per cent. (15 per cent. being a usual mean); the average sometimes rising, in the case of special articles or items of food, to 30 per cent. or upwards. The deduction is principally in regard to the more substantial articles of diet, such as meat, oatmeal, bread and cheese; and it is proportioned to the less requirements of the system,—the smaller amount of physical labour or exercise,—of females as compared with males.

Estimation of Nutritive value of Dietaries of this Institution.

Differences between Male and Female Dietaries

* *Cornhill Magazine*, vol. iv., 1861, page 293.—Article on "Food: how to take it:" one of a series of Papers on Popular Dietetics, abounding in interest and instruction; and which, as such, we can confidently commend for general perusal.

Difficulties in estimation of Nutritive value of Public Dietaries.

Calculations on the nutritive value of Foods are attended by difficulties of a kind and to an extent that can only be conceived by those who have actually essayed such inquiries. It is, however, unnecessary to specify in detail what these difficulties are—wherein they reside; and we refer to them at all simply as one reason for the non-attainment of perfect accuracy or exactitude in results. A professional chemist, of whose kind aid we had the advantage at a particular stage of our inquiries, and who could be no novice to such investigations or calculations, wrote us that the estimation of the nutritive value of our printed Diet Tables "would embrace work "enough for a staff of 4 or 5 clerks for several hours a-day for a week," leaving out of view his own superintending or supervising labours. He found, for instance, 10 separate calculations necessary for the determination of the nutritive value of the *soups* used by the *pauper* class alone; and many other items required calculations equally "numerous and complex." This is far from an exaggeration of the labour inherent in, or inseparable from, such an inquiry. It has cost ourselves the leisure of several weeks,—with the aid of the House-steward of the Institution,—to educe the results now tabulated or generalised. These results, notwithstanding all the pains bestowed on them, can claim only approximative accuracy and a limited scientific value; but they may still be useful in forwarding the main object we had and have in view,—the improvement of our Dietaries in relation to their specific suitability to individual patients and to groups or classes thereof.

Approximative accuracy only attainable.

Dietaries for paupers:

First among the dietaries of the patients or inmates of this Institution we place that for the pauper class as being *quoad* the patients the *typical dietary*. It is typical both as respects the amount of solid nutriment and food supplied: the quality or nutritive value of that food: and its superior economy. Compared with the dietaries of the higher classes of patients, it is at once seen to be the fullest and simplest; for the dietaries of the upper ranks of patients differ from that of paupers chiefly as regards a different class or type of food—a greater variety therein, and a greater expensiveness thereof—unattended, however, by greater nutritive value. Inasmuch as a separate pauper dietary will soon be no longer here required, we deem it unnecessary to make the criticisms or suggest the alterations we should otherwise have done. But, in so far as we conceive this dietary to be infinitely preferable or superior, in point ot nutritive value, to the higher or more expensive classes of dietaries, we would strongly commend the extension of this type of dietary,—of this class of Foods,—where possible or admissible—to the higher classes of patients. We

their comparative superiority

allude mainly to the porridge and milk, which constitute the daily feature or characteristics, of the pauper dietary; or to substituted foods of a similar class. In connexion, however, with any such innovations on the dietaries of the higher ranks of patients, difficulties of a formidable character at once meet us, in the shape chiefly of popular prejudices anent Foods, and the previous bad habits of patients in respect of Food-taking. The middle and upper ranks of society are too much—for their own health—in the habit of using tea or coffee diets; a practice which may be characterised as essentially the imbibition of a considerable amount of tepid water; the administration of a nervine stimulant or calmative; and the consumption of a very limited amount of solid nutriment in the form of bread, milk, butter, and sugar. There is a "fashion" in foods; and unfortunately present fashion leads people to prefer, for instance, tea and coffee to porridge and milk diet; the finest white bread, adulterated with alum and made of the purest flours, to that made of whole flour or 2nd qualities—to the brown or so-called "coarse" breads, which are infinitely more wholesome; to confine themselves too much to wheaten breads to the exclusion of other breads or Foods composed of rye, oats, or barley—of pease, lentil, revalenta—or other highly nutritive cereal or leguminous flours; to select chicory-adulterated coffee rather than the pure berry; to boil their tea and spoil it by converting it into a strong solution of Tannic acid; to deliberately waste the important saline constituents of vegetables,—which are so indispensable to nutrition that they *must* be supplied in some other, and probably more expensive and questionable, form,—by discarding the water in which they have been boiled. Porridge and milk the mass of the community regard as a necessity for the poor,—necessary on the score of its comparative economy as a diet; but they cannot look upon it as a *luxury for the rich*. Nevertheless, where admissible or suitable,—in relation to the digestive powers of the consumer and the amount of physical labour he undergoes or exercise he undertakes, there is no morning diet comparable to porridge and milk for any class of the community. It by no means detracts from the general merits of this recommendation that such a diet is, in many cases, contra-indicated or inadmissible; these are exceptional cases of depraved taste or depraved habits,—of unhealthy conditions of the digestive system, or of idiosyncrasy. Chemistry and physiology, science and experience alike point out, in unmistakeable characters, that the diet, which is the simplest and the cheapest, is frequently also the most nutritious and natural; and that the pauper and ploughman, *quoad* his diet, is infinitely better off than his richer and more fastidious fellow. The robustness and vigour of the Scottish peasantry on

Porridge and milk as a type of diet.

Popular prejudices and fashions in diet.

Illustrations of depraved tastes.

Comparison of diets of lower and higher classes.

their oat and pease-meal foods (their "brose" and "porridge"—"cakes," "bannocks" and "scones"); or of the Scandinavian peasantry on their rye and barley breads and porridge, are familiar illustrations of the truth of the proposition that foods of such a class, well cooked, with abundance of fresh milk,—occasional supplies of animal food and a variety of vegetables—are types of diets for healthy men, engaged in active out-door occupations or exercise. We must not, however, be supposed to lay too great stress on the importance *per se* of

"The halesome *Parritch*, chief o' Scotia's food;"

or even of its appropriate accompaniment milk,—though of all composite Foods the latter is avowedly the most nutrient—the most natural. We refer rather to the simple class of diets, of which porridge and milk are but a type or example. There are few, if any fluids, we can substitute with advantage for milk: but we can supply instead of unvarying oatmeal, such cereal flours as wheat, rye, or barley meal,—or such leguminous flours as pease, lentils *et hoc genus omne*; so as to secure sufficient variety with a high nutritive power in all cases.

Pauper Dietary.

TABLE SHOWING THE AVERAGE WEEKLY CONSUMPT OF EACH MALE WORKING *PAUPER*.

	Actual Consumpt of Food in oz. Avoirdupois.	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboni-ferous.	Total Solid Nutriment.
1. Meat—*a*.—Butcher-meat—(Beef, Mutton, Pork,—all of best quality),	35*	5·25	8·40	13·65
b.—Poultry, Rabbits, and Game,	—	—	—	—
c.—White Fish, ...	8	1·20	0·56	1·76
2. Eggs, (1)	—	—	—	—
3. Cheese—best Goods, ...	6	2·88	1·80	4·68
4. Milk—Sweet—average sp. gr. 1032 ..	133	5·32	10·64	15·96
5. Bread,—White—best quality of Wheat,	104	8·32	54·08	62·40
6. Oatmeal—best Scotch, ...	51	8·67	36·21	44·88
7. Wheaten Flour—best, ...	7	0·98	4·97	5·95
8. Barley—best Pot, ...	4	0·56	2·88	3·44
9. Rice.	2	0·12	1·76	1·88
10. Pease—split, ...	3	0·72	1·77	2·49
11. Sugar—average raw, ...	9	—	5·88	5·88
12. Butter—best Scotch salt, ...	5	—	2·85	2·85
13. Fat, Suet, and Lard, ...	5	—	5·00	5·00
14. Potatoes.	68	1·36	17·00	18·36
15. Miscellaneous Vegetables, .. } 16. Do. Fruits, ... }	27	0·81	4·05	4·86
Mean daily consumpt per patient, ..	66·70	5·17	22·55	27·72
Abstract showing the relative Proportions of Animal and Vegetable Food and Nutriment—				
1.—ANIMAL.—*a*. per Week, ..	192·00	14·65	29·25	43·90
Do. *b*. ,, Day, ..	27·42	2·09	4·18	6·27
2.—VEGETABLE.—*a*. per Week, ..	275·00	21·54	128·60	150·14
Do. *b*. ,, Day, ..	39·28	3·08	18·37	21·45

* After deducting from a total of 53 oz., about 34 per cent., or 18 oz. for bones and fat.
1. Occasionally only—when on sick list or extra diet.

This Pauper Dietary Table does not exhibit, nor can any such table, however skilfully drawn up, adequately set forth or explain the extent to which the Food of the pauper class of patients is added to, or varied, by the remnants of meals of the higher classes; the changes that are frequently introduced when some special article of diet is scarce, such as milk, fish or fruit, or another abundant; the variations of diet with season,—the greater abundance of vegetables and fruits,—of farinacea and milk,—in the summer diet—and of meat and bread, dumplings and puddings in that of winter.

Variations in Pauper Dietary.

The Dietary for the Intermediate Classes* of patients seems susceptible of improvement, especially in regard to the amount of the nitrogenous constituents of the foods supplied. This deficiency we would rectify or supply by a certain amount of porridge diet to breakfast, with a corresponding increase of milk, rendering such diet, however, optional: by a considerable increase in the allowance of cheese: by a larger consumpt of eggs, in the form chiefly of puddings of various kinds: by a greater use of pease, in the form of pea-soup or pudding, or by the substitution of equivalent quantities of similar leguminous flours, such as revalenta, in the form of soups or puddings: by the use of such substances as macaroni and vermicelli: by a greater approximation, in a word, to the Maximum Pauper Dietary, which would imply the substitution of more solid and nutritive foods for the tea and coffee and farinaceous diets presently in use.†

Dietaries for Intermediate Classes.

Proportion of Nitrogenous Nutriment.

In all classes of our Dietaries we would strongly urge the substitution of *Cocoa*, in some of its many and pleasant forms, for tea and coffee—to a certain extent at least. We would by no means discard tea and coffee, which in certain cases might be preferable as mere neurotics to cocoa. They have become national beverages—whether rightly or wrongly, especially in comparison with other beverages that might be substituted, we do not seek here to inquire: all classes of society, including the lower orders, are now so wedded to the use of tea that it is too generally impossible to persuade them to give up its use in favour of chocolate: old-standing prejudices and habits are, under all circumstances, difficult of removal: and we do not consider an Hospital for the Insane the proper place—taking advantage of the helplessness of our charges—to introduce compulsory reforms in diet, which are too likely to be regarded as arbitrary punishments. As a beverage for habitual use there is no comparison between cocoa on the one hand, and tea and coffee on the other; all 3 substances possess the same kind and amount of stimulant or calmative alkaloids: Theine in the case of the 2 latter, Theobromine in that of the former. Theobromine is, however, richer *in nitrogen* than Theine, the active principle of

Cocoa: as a substitute for Tea and Coffee.

Their respective uses & comparative advantages.

* *Vide* Appendix, Pages 14 and 27.
† We would also strongly commend the introduction to a large extent—as a garnishing to meats, or as an ingredient of soups and stews—of leeks and onions—especially Portugal onions. As compared with other classes of vegetables usually presented at table, Onions are highly nitrogenous and nutritious: so much so that, in the Navy Ration-Regulations, they rank as of *four* times the nutritive value of any other kind of vegetables generally used as food.

tea and coffee; and this may be supposed to be an advantage when we bear in mind that it is on the amount of this element, nitrogen, that the plastic or tissue-forming power of foods has been proved to depend.

Mal-preparation of Tea and Coffee.

As we use them in this country, tea and coffee cannot be said, in any true sense of the term, to be foods proper; they do not add solid matter to the fabric of the body; they are pure stimulants or alteratives, belonging to the category of Dietetic Medicines—having, however, as such, important uses in the economy. Though the soda, so commonly added by the careful housewife to "soften" the water in which tea is infused, or coffee boiled, enables the said water to dissolve out a small proportion thereof, we may be said, in our mode of preparing them, habitually to waste the nitrogenous or solid nutriment of tea and coffee, which in the one case resides in the leaves, and in the other in the berry—neither leaves nor berry being themselves by us consumed.

Cocoa a Food proper.

On the other hand, chocolate, or any form in which the whole cocoa bean is presented, while belonging with tea and coffee to the class of Dietetic medicines, pertains equally to the category of foods proper. It has the advantage of containing no less than 50 per cent. of butter, 20 of albumen, and 7 of starch—in other words, 22 per cent. of nitrogenous, and 69 of carboniferous, constituents; and thus it supplies solid nutriment to the extent of 91 per cent.—a circumstance that gives it a high position as a food proper, leaving out of view its advantages as a merely stimulant beverage.

Comparison between Dietaries of Patients and Staff.

It has appeared to us desirable to contrast the Dietaries of the Patients with those of various classes or grades of the Staff of the Institution. The only dietary superior, as respects the amount of dry nutriment supplied, to that of the Pauper, is that of the Attendants and Servants. The difference in favour of this class of officers is strictly in accordance with physiological principles: and is dictated equally by science, policy, and economy.

Dietary for Attendants.

The attendants and servants are all picked individuals—selected, among other qualities, for their physical robustness: they are thus generally eminently healthy and able-bodied—especially in contrast with the fragile physique or depraved vitality of the patients as a class; they are called upon to undergo or undertake a large amount of physical labour, especially such of them as work in the garden and grounds or in the laundry; and all of them have a large modicum of open-air exercise. Further, their duties involve a large measure of mental labour, care, anxiety, and responsibility, from which the patients are entirely free. The operation of such a cause can only be duly estimated by the light of the recent researches of Professor Haughton, of Dublin, and others, on the influence of mental labour and of mental anxiety as a cause of

physical exhaustion and of tissue-waste. The physiological requirements of the system are, therefore, much greater than in the case of pauper patients—even the out-door working classes thereof; the tissue-waste is greater, and its due repair or replacement is demanded at the expense of a correspondingly larger amount of substantial nutriment.

Food in relation to work.

Moreover, in the case of our attendants and servants, a certain amount of *work is exacted* and obtained; the food is supplied specially with a view to this end, and must be correspondingly liberal and nutritious, else we fail in our object. Dr Letheby* shows that the same man, who, while leading simply a vegetative life, requires for the performance of the vital operations a daily average of 16 oz. of solid nutriment, must have, when he becomes a soldier, 24 oz., and when he becomes a Yorkshire labourer or railway navvy, 51 oz. All statistics go to prove that work and food stand in an intimate or inseparable relation to each other; and that, where a high quality, or large amount of work, whether bodily or mental, is required, the food-supply must be correspondingly liberal.

Economy and policy of liberal Dieting.

Such a procedure is the most economic as well as the most scientific. Whatever improves physical health or maintains it at its highest degree or point of usefulness is economical, inasmuch as it secures the largest possible return in work in proportion to the expenditure in food; inasmuch as disease and ill health are always expensive, always attended with, or lead to, loss in a great variety of ways. Even in a financial or pecuniary point of view—in the merely mercantile or profit-and-loss aspect of the question—it is clearly our best policy or interest to supply a class of officers, on whose vigour of body and mind so much of the prosperity or usefulness of an Asylum depends, with an abundant and adequate supply of the most suitable nutriment. On the other hand, we do not supply food to our Patients *in order that they may work;* but they work in order that they may properly digest their food, and generally improve their physical and mental health. The 2 classes of persons we have been contrasting—Attendants and servants of the Institution on the one hand, and Pauper patients on the other—are, in this respect, quite differently circumstanced. The one class is here as workers—paid and fed as such; the more work they contribute, the more useful they are,—the more profitable and satisfactory our investment in their services. The other class comes here as patients to be treated for mental, and generally also for associated physical, disease;

Insane in position of Invalids in relation to Diet.

in a large proportion of cases work is impossible or inexpedient; and where it is both possible and expedient, it is prescribed just as *regimen*, medicine or moral treatment is prescribed,—as a remedial measure, its nature and amount being suited carefully to the capabilities or requirements

* *Vide* Table IX. Appendix, page 24.

of each individual. This is a circumstance requiring to be borne in mind in instituting also any comparison between the Dietaries of our patients and those of soldiers or sailors, labourers or navvies, who are fed specially with a view to the exaction of work, and that generally of a severe physical character. Our Dietaries are more fairly comparable with those of a general Hospital or Infirmary, the inmates of which are patients under treatment for a variety of physical ills, and subject to a certain amount or degree of restraint, confinement, or discipline—who are, more or less, for the time being, sedentary in their habits or occupations.

Attendants' Dietary :

TABLE SHOWING THE AVERAGE *WEEKLY* CONSUMPT PER PERSON BY ATTENDANTS AND SERVANTS.* †

	Actual Consumpt of Food in oz. Avoirdupois.	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carbonaceous.	Total Solid Nutriment.
1. Meat—a.—Butcher-meat—(Beef, Mutton, Pork,) ..	60 (2)	9·00	14·40	23·40
b.—Poultry, Rabbits, and Game,	16 (3)	1·50	2·40	3·90
c.—White Fish, ...	12	1·80	0·84	2·64
2. Eggs (1)	—	—	—	—
3. Cheese, ...	14	6·72	4·20	10·92
4. Milk—Sweet—sp. gr. 1030-5, ...	70	2·80	5·60	8·40
5. Bread, ...	140	11·20	72·80	84·00
6. Oatmeal, ...	—	—	—	—
7. Wheaten Flour, ...	2	0·28	1·42	1·70
8. Barley, ...	5	0·70	3·60	4·30
9. Rice, ...	2	0·10	1·70	1·80
10. Pease—split, ...	5	0·72	1·77	2·49
11. Sugar, ...	16	—	15·68	15·68
12. Butter, ...	10	—	9·50	9·50
13. Fat, Suet, and Lard, ...	4	—	4·00	4·00
14. Potatoes, ...	140	2·80	35·00	37·80
15. Miscellaneous Vegetables, .. }	28	1·02	5·10	6·12
16. Do. Fruits, ... }	6			
Mean daily consumpt per person, ..	—	5·32	25·43	30·95
Abstract showing the relative Proportions of Animal and Vegetable Food and Nutriment—				
1.—ANIMAL —a. per Week, ..	186·00	21·82	40·94	62·76
Do. b. „ Day, ..	26·71	3·12	5·85	8·97
2.—VEGETABLE.—a. per Week, ..	344·00	16·82	137·07	153·89
Do. b. „ Day, ..	49·14	2·40	19·58	21·98

Its peculiarities.

A peculiarity of the Dietary for Attendants and Servants resides in the absence therefrom of *Oatmeal* in any form. They have the option of a porridge and milk or tea and coffee diet, morning and evening; and they universally prefer the latter. Herein they not only show their bad taste, but their ignorance, or disregard, of the comparative nutritive value, and of the physiology, of foods. Unfortunately undoubtedly for themselves, they share in the prejudices of the classes of society above them, and regard the most expensive diet as necessarily the best and most desirable—looking down on such

Preference of Tea and Coffee Diets.

1. Only occasionally—when on night duty—in lieu of meat or cheese.
2. After deducting about one-third or 33 per cent. for bone, suet, &c.
3. Do. do. one-fifth or 20 per cent. for bone, &c.
* Mean of both sexes.
† *Vide* Appendix, Table IV. page 18.

articles as porridge, and brown or coarse bread, as inferior and despicable. With such prejudices, opinions and habits, it is inexpedient to render compulsory a diet, which is regarded, though most unjustly and erroneously, as coarse, inferior, and degrading, or to force upon any class, either of officers or patients, what is considered a punishment, while it is intended as, and is really, a boon. Past experience has proved that the use of such a diet as porridge and milk is looked upon as an indignity, and resented as such: though it is greatly to be regretted this should be the case. Under existing circumstances, we can only offer the option of selecting a diet inferior in nutritive power, albeit it is not inferior also in cost; trusting that, in due time, the excellent class of officials, whose best interests we have under review or consideration, may be educated, or led spontaneously, to adopt a wiser procedure.

Dietetic Punishments.

The Dietary of the resident Officers* of the establishment represents, as to quantity, quality, and variety (the 3 cardinal points of Diet) that of the average of the middle and upper ranks of society, who have the freedom of purchasing what food they please, and using it as taste may dictate. We can speak of it from long personal experience and use as quite sufficient, in respect of the quantity and kind of solid nutriment supplied, for adults of either sex, in the most affluent positions in society.

Dietary for Resident Officers.

TABLE SHOWING THE AVERAGE *DAILY* CONSUMPT BY THE *PHYSICIAN*.

Dietary of Physician.

	Actual Consumpt of Food in oz. Avoirdupois.	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carbonaceous.	Total Solid Nutriment.
1. Breakfast—8 A.M.—				
Bread—best wheaten—white, ..	8·00	—	—	—
Butter—salt or fresh—best Scotch,	2·00	—	—	—
Eggs—(deducting 0·25 to 0·60 per cent. for shell), ...	4·00	—	—	—
Milk—sp. gr. 1035—sweet or skimmed,	3·00	—	—	—
Cocoa (nibs), ...	0·25	—	—	—
2. Lunch—1 P.M.—				
Bread, ...	3·00	—	—	—
3. Dinner and Tea—6 P.M.—				
Meat—fresh—lean—without bone—(beef or mutton),†	7·00	—	—	—
Bread, ...	6·00	—	—	—
Butter, ...	1·00	—	—	—
Milk, ...	3·00	—	—	—
Cocoa (nibs), ...	0·25	—	—	—
Total or aggregate consumpt per day—				
Meat, ...	7·00	1·05	1·68	2·73
Bread, ...	17·00	1·36	8·84	10·20
Milk, ...	6·00	0·24	0·48	0·72
Cocoa, ...	0·50	0·11	0·36	0·47
Eggs, ...	4·00	0·52	0·48	1·00
Butter, ...	3·00	—	2·85	2·85
Total, ...	—	3·28	14·69	17·97
Abstract showing the relative Proportions of Animal and Vegetable Food and Nutriment—				
1. Animal, ...	20·00	1·81	5·49	7·30
2. Vegetable, ...	17·50	1·47	9·20	10·67

* *Vide* Table XV., Appendix, page 28.
† Occasional substitution of poultry, or white fish (haddock or cod).

The Dietary of the Physician is the result of actual daily measurement and experiment, and is consequently more accurate and precise in its figures than the other dietaries can be. It is given as an ample, typical dietary, under ordinary circumstances of work, exercise, and health, for adult males, of from 30 to 50 years of age. It represents the average daily consumpt, we believe, of a large proportion of males in the middle and upper classes of society; such especially as, on account of the character of their professional avocations, or their natural habits or tastes, lead comparatively sedentary lives. We refer, for instance, to a large proportion of the medical, legal, and clerical professions—to litterateurs and scientific men—to merchants and their clerks, and to the officers of all grades in various departments of H. M. Civil Service. This and the preceding class of dietary are, as compared with the others which have been reviewed, practically unlimited. No restriction is placed on the quantity or quality of food: on the amount of the nitrogenous and carboniferous constituents respectively; nor on their proportion to each other. Taste, fancy, means have been permitted to select what were considered the best foods of different classes; and yet the result is, as compared with the regulation or compulsory dietaries of this Institution, that the latter are greatly superior to the former in regard to their substantiality, or the proportion of solid nutriment they contain. Hence, again, it would appear that the more expensive and varied diets of the affluent cannot compare with the coarser, simpler, and more economic fare of the pauper—looking simply to the nutritiveness of foods, relative to the wants of the healthy

Optional and unlimited Dietaries.

Typical dietary for middle and upper classes.

Superiority of Dietaries of Paupers quoad economy, simplicity, and solid nutriment.

ABSTRACT OF TABLES ILLUSTRATIVE OF THE NUTRITIVE VALUE OF THE DIETARIES OF MURRAY'S ROYAL INSTITUTION:
showing the average daily consumpt per person of dry or solid nutriment in food.

	Per Centage of Solid Nutriment in oz. Avoirdupois.		
	Nitrogenous.	Carboniferous.	Total Solid Nutriment.
I.—PATIENTS.			
1. Paupers—			
a. Male working paupers, ...	5·17	22·55	27·72
b. General average—estimate by Dr Murray Thomson, .. a. Males,	5·25	17·00	22·25
b. Females,	4·00	13·75	17·75
2. Intermediate classes—general average, ..	3·94	21·77	25·71
3. Higher do. do., ...	4·57	23·27	27·84
4. General average of the whole inmates of the Institution,	4·30	20·82	25·12
Mean of the foregoing 6 classes of Dietaries,	4·54	19·86	24·40
II.—STAFF OF THE INSTITUTION.			
5. Attendants and servants, ...	6·52	23·43	29·95
6. Officers, ...	3·34	15·38	18·72
7. Physician, ...	3·28	14·69	17·97
Mean of the foregoing 3 classes of Dietaries,	4·05	18·50	22·55

system. A comparison of all the classes of the Dietaries of this Institution—including alike those of the patients and of the staff—brings out the fact that the highest in rank, in regard to its abundance of solid nutriment, is that of the Attendants, while the lowest is that of the Physician:—that of the out-door working male paupers ranking next to the attendants' dietary in point of superiority, while that of the resident Officers ranks next that of the Physician as respects inferiority.

We have thought it proper also to institute such comparison as was possible or legitimate between our Dietaries and those of various public institutions of a kindred class—those of the public services, and those of certain classes of the general population—with a view to ascertain or fix the position which the dietaries of this Institution hold, in regard to their nutritive value, in relation to public dietaries in general. We are enabled to do this, so far as is necessary or desirable, by two tables or extracts therefrom—published by Dr Letheby and Dr Lankester respectively.* From them it would appear that our pauper dietary, as given at page 38, stands far above the physiological requirements of the healty adult:—far above the dietaries of public general hospitals; of public lunatic asylums—British and foreign; of British paupers; of indigent old men or pensioners; as well as above those of the army and navy—even of soldiers and sailors on active service. The only classes of persons having a fuller or superior dietary, in point of the quantity of solid nutriment supplied, are navvies and labourers, whose immense amount of physical work calls for a correspondingly large supply of substantial nourishment.

Comparison between Dietaries of this Institution and other Public Dietaries.

We have already pointed out that our dietaries are not fairly comparable with those of healthy adults, capable of, and called upon for, a habitually large expenditure of physical force and substance—such as soldiers, sailors, navvies, and labourers. Those of a General Hospital or Infirmary are more analogous to those of an Hospital for the Insane, insofar as the consumers are more of the same class—that of invalids—with a lowered vitality or vitiated physique, in whom peculiarities of physical and mental health, of natural constitution, of present habits, occupation, and exercise, call for various departures or differences from the dietaries adapted to their more vigorous and more fortunate fellows. Such is the proportion in every asylum of aged, feeble, and helpless inmates—of the paralytic and childish, of the sick and dying, of cases requiring sustenance for long periods by artificial means, that our actual dietaries resemble greatly in their number and variety, as well as, to a certain extent, in their kind, the numerous diets of a well-regulated public general hospital. As a

Comparison with Infirmary Dietaries.

* Tables IX. and X. Appendix, pp. 24 & 25.

Dietaries of Royal Infirmary of Edinburgh.

specimen of the dietaries of public general hospitals, we select those of the Royal Infirmary of Edinburgh,* both because we are best acquainted with that institution and its classes of inmates, having spent a portion of our medical novitiate within its walls, and in its service; and because its dietary tables have been drawn up with unusual care by some of our most eminent authorities on Dietetics, especially Professor Christison. These dietaries illustrate the following points of considerable interest as bearing on the whole question under consideration:—

Minimum Nutriment necessary to sustenance of Life.

1. The small quantity of dry nutriment that is requisite simply to sustain life in the best possible way; and at the same time the maximum that is admissible in certain states of physical health or disease:—about 7½ oz. per day in the case of "*low diet.*" This is of importance in connection with the compulsory alimentation cases to be found in the wards of every asylum, where sustenance is persistently and perversely refused for long periods, and where feeding by the stomach-pump or injection apparatus becomes necessary.

Average daily consumpt per person of solid Nutriment.

2. The ordinary or most common diet of convalescent infirmary patients,—whose physical condition is probably not below that of the majority of the inmates of public asylums,—contains a daily average of from 13½ to 19 oz. solid nutriment, the mean being 16 oz., an amount that falls far short of that supplied in the dietaries of this Institution.

Profuseness not a measure of Fitness.

3. The mean of all classes of dietaries (amounting to 9) gives an average allowance per day of about 15 oz. only of solid nutriment. This would *pro tanto* lead to the inference that the allowance of solid nutriment in this Institution is *excessive*; and that dietaries, fullest or most profuse in respect of their proportion of solid nutriment, are not those necessarily best adapted to the community of Hospitals for the curative treatment of sane or insane Invalids.

* *Vide* Tables VII. and VIII., Appendix page 23.

COMPARISON, IN RESPECT OF NUTRITIVE VALUE, BETWEEN THE GOVERNMENT DIET TABLES FOR THE LUNATIC WARDS OF POORHOUSES IN SCOTLAND,† AND THE DIETARIES OF MURRAY'S ROYAL INSTITUTION.

Dietaries for Lunatic Wards of Poorhouses.

		Average Daily Allowance or Consumpt per Person of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboniferous.	Total Solid Nutriment.
I.—Poorhouse Dietaries.				
1. *Minimum* scale—according to clause 11 of the "Regulations" anent Poorhouse Lunatic Wards—issued by the Board of Lunacy for Scotland in Septem., 1862—	Regulation Allowance.			
a. Males, ...		5·00	15·00	20·00
b. Females, ...		5·00	13·00	18·00
c. Mean of both sexes, ...		5·00	14·00	19.00
2. *Maximum* scale for out-door working *males*—deduced from the Diet Tables contained in the "Regulations" aforesaid, ...		6·10	20·31	26·41
3. *Minimum* scale for all classes of *males*—deduced from same Tables, ...		4·38	17·10	21·48
4. *Mean* of the foregoing Maximum and Minimum Scales,		5·24	18·70	23·94
II.—Murray's Royal Institution Dietaries.	Actual Consumpt.			
5. Male Working Paupers, ...		5·17	22·55	27·72
6. Average of all classes of Patients of both sexes, ..		4·30	20·82	25·12
7. Attendants and Servants, ...		5·52	25·43	30·95
8. Mean of *five* classes of Dietaries,*		4·70	22·77	27·47

The most recent, and at the same time among the best, Dietary Tables with which we can compare certain classes of those of this Institution are those lately drawn up by the Commissioners in Lunacy for Scotland, with the sanction, or under the counsel, of Professor Christison, for the Lunatic Wards of Poorhouses. In their regulations anent the said Lunatic Wards (clause 11) the Commissioners fix the minimum scale of diet as follows:—"The diet shall be regulated by "the tables appended to the present rules, or by tables specially sanc- "tioned by the Board for individual poorhouses; but all such special "tables shall show *a daily minimum average quantity of twenty ounces* "*of dry nutriment for each male, and of eighteen ounces of dry nutri-* "*ment for each female, of which at least five ounces shall in each case be* "NITROGENOUS." The diet tables or scales for both sexes referred to are admirable, both as to the quantity, quality, and variety of food. The great advantage, however, of such diet tables or regulations seems to reside in the fact that a dietary so ample *secures a sufficiency of nutriment to every inmate by providing excess.* For the mere physiological wants of the system so large an amount of dry nutriment is unnecessary—in relation to the classes of the community for which these dietaries are provided; and, indeed in relation to any classes of the general population—save in the case of hard-working, able-bodied

Proportion of Nitrogenous to Carboniferous Nutriment.

Sufficiency, by excess, of Nutriment.

* *Vide* Table X. Appendix, page 25.
† *Vide* also Tables V. and VI., Appendix pp. 20-22

adults—the proportion appears excessive. The error, however, if error it be, is on the safe and right side. More especially do the *nitrogenous* constituents seem superabundant; seeing our tables show that 3·50 oz. per day suffice for large classes of the population in this country; and so large an amount as 5 oz. can scarcely be required by constitutions such as those of the inmates of the lunatic wards of poorhouses. There is perhaps less excess as regards carboniferous constituents, inasmuch as our statistics show 10 to 15 oz. per day to be a fair average requirement and allowance.

General considerations on Dietaries.

There are certain general considerations by which we have further to measure the fitness of our Dietaries in reference to the specific use or purpose for which they are intended. These refer, on the one hand, to certain qualities in a diet itself; and, on the other, to certain qualities in its recipient or consumer: without a combination of which 2 classes of qualities no diet can be properly suited for its great aim and end—that of healthy nutrition. The qualities in the diet itself, constituting its *nutritiveness* and *fitness*, are the following:—

Qualities constituting Nutritiveness.

1. Its quantity—especially in relation to the amount of dry or solid nutriment. This head may properly embrace the proportion to each other of the nitrogenous and carboniferous constituents of the foods forming the diet.
2. Its quality—including a consideration of the
   - *a.* Chemical composition of foods.
   - *b.* Their mechanical properties.
   - *c.* Their digestibility.
   - *d.* The relative proportions of animal and vegetable sustenance.
   - *e.* The nature and amount of combinations or intermixtures.
3. Its variety—especially in relation to season, occupation, exercise, habit, constitution, &c.
4. Its condition in relation to cooking:—as bearing on loss of weight, and the superior nutritiveness and digestibility of the same foods, under different circumstances of preparation. Here may appropriately be associated, more however in a psychical and æsthetical, than in a physical sense, the mode of serving foods.
5. The addition or use of various accessories (chiefly of the stimulant and alterative class, falling under the category of Dietetic medicines) as aids to digestion.

Digestive capacity of Consumer.

The qualities in the recipient or consumer are mainly his—

1. Physical condition } as to health or disease.
2. Mental condition }
3. Idiosyncrasies and peculiarities of nervous organisation and influence—including the natural and the morbid—congenital and acquired.
4. Habits as to *a.* Occupation, especially the nature and amount of physical labour.
   - *b.* Exercise, especially the proportion which is out-door and of an active character.
   - *c.* Food—previously acquired or formed, including depraved and unnatural tastes.

Physiological requirements of system as to quantity of food.

In all considerations as to the *quantity* of foods necessary to the constitution of a normal, model or typical Dietary for any class of persons, it is necessary, as a preliminary, to secure a *standard* by determining what are the *physiological requirements of the system in health;* what is the average amount necessary for the support of life in the best possible way: what will maintain in an adult the weight of his body unchanged, during the vigour of life under ordinary or average circumstances or conditions as to health, occupation, and exercise. Dr Letheby states the amount so required at 4 oz. nitrogenous; 12 oz. carboniferous; and 16 oz. total solid nutriment per day. This is probably a theoretical estimate, based on the chemistry and physiology of food in the abstract. Subjoined are 2 careful estimates apparently of a more practical character, representing the actual average daily *consumpt* by the healthy male adult. Their mean gives in round numbers $3\frac{1}{2}$ oz. nitrogenous; $15\frac{1}{2}$ oz. carboniferous; and 19 oz. total solid nutriment.

Different estimates of average for healthy adult.

TABLE SHOWING TWO ESTIMATES OF THE PHYSIOLOGICAL *DAILY* REQUIREMENTS OF SOLID NUTRIMENT BY THE HEALTHY MALE ADULT SYSTEM.

	Rough Weight of Food in oz. Avoirdupois.	Per Centage † of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboniferous.	Total Solid Nutriment.
I.—Result of actual experiment by Dr Dalton—representing the quantity required and consumed in 24 hours by a man in full health,—taking free exercise in the open-air—*				
1. Meat, ...	16·00	2·40	3·84	6·24
2. Bread, ...	19·00	1·52	9·88	11·40
3. Butter (or fat), ...	3·50	—	3·40	3·40
Total, ...	—	3·92	17·12	21·04
II.—Average requirements of healthy men,—engaged in average physical labour and taking average open-air exercise—(being the mean of the most recent experimental results of Physiologists)—*				
1. Meat, ...	12·00	1·80	2·88	4·68
2. Bread	20·00	1·60	10·40	12·00
3. Butter, ...	0·50	—	0·47	0·47
Total, ...	—	3·40	13·75	17·15
Mean of 2 series of estimates, ..	—	3·66	15·43	19·09

* "Cornhill Magazine:" Article on "Food; how to take it." Vol. IV., 1861., Page 288.

† This and all other calculations of per centage of solid Nutriment are made on the basis of our Standard Table. (*Vide* Page 31.)

Personal conclusions.

Our own inquiries lead us to the following conclusion or result:—that, in relation to all classes of the general population of this country—including alike the rich and poor—healthy and infirm—industrious and idle—of both sexes, a diet, which embraces a daily average allowance of from 3½ to 5 oz. dry nitrogenous, and from 10 to 20 oz. dry carboniferous nutriment—including a due proportion of salts—that is, from 15 to 25 oz. total solid nutriment—is an ample and sufficient one—regarded simply as a type or standard. In regard to the special population of our Public Lunatic Asylums, we have been further led to consider a fair average dietary as one comprising 4 oz. nitrogenous, and 13 oz. carboniferous and mineral, or 17 oz. total solid nutriment: while one containing 5 oz. of nitrogenous, and from 15 to 20 oz. of carboniferous and mineral food is *ample to excess*, and is far beyond either the physiological requirements, or the digestive and assimilative capacity, of the majority of the patients.

Proportion of Nitrogenous to Carboniferous constituents of Food.

The proportion which the nitrogenous bear to the carboniferous constituents of food, in various estimates of the physiological requirements of the system, as well as in various public Dietaries, is set forth in a table we have carefully compiled from the highest authorities.* Professor Liebig, and following him Professor Gregory of Edinburgh, regard the best proportion for a working man in health as 5 parts carboniferous to 1 part of nitrogenous nutriment; while Dr Letheby lays down the higher proportion of 3 to 1, and other estimates as 4 to 1. Whether Liebig be right or wrong in his estimate, it happens that the Dietaries of this Institution come nearer his standard than any others in the table in question—representing the proportion of 4½ to 1; while in the very excellent diet scales for the Lunatic Wards of Poorhouses, the proportion stands at about 3 to 1. This proportion or relation, whatever it may be, and which must vary with circumstances, requires nice adjustment: otherwise there must result, on the one hand, great loss of material, or, on the other, depraved vitality or disease from inadequate nutrition. A deficiency, for instance, of the carboniferous element in diet necessitates an enormous and extravagant use of nitrogenous constituents for the purpose of maintaining the animal heat. Professor Gregory estimates (after Liebig) the quantity of fresh lean meat required to yield the same amount or degree of animal heat as 100 parts of fat, at 770 parts or upwards of 7 times as much; of rice, equivalent for the same purpose to 33 parts of fat pork, at 123 or nearly 4 times as much. The converse is equally true, an enormous expenditure of the more properly carboniferous or farinaceous foods being called for by any shortcoming among those that are more strictly nitrogenous. The same high authority calcu-

Necessity for due adjustment.

Nitrogenous and Carboniferous Foods as mutually substitutional.

* *Vide* Table XI., Appendix, page 25.

lates that as substitutes, the one for the other, the equivalent of 27 parts lean beef is 125 parts of potatoes or about 5 times as much. It is necessary here to remember further that the quantity of food available for nutrition is limited to a certain extent by its bulk, and the physical capacity and digestive power of the stomach; hence large masses of such articles of food as rice or potatoes are, in ordinary circumstances, in this country, quite inadmissible. The proportion that ought to subsist between the nitrogenous and carboniferous constituents of foods must be judged of by various considerations to follow. The sedentary or passive, for instance, require less nitrogenous, and perhaps proportionally, more carboniferous food than the vigorous and active; and the diet most suitable for them as a class is probably to be found (selecting *types* always) in milk associated with the farinacea, or in a vegetarian diet. True it is that, under such circumstances, "a "less vigorous life may thus result; but it may be the best attainable and the most truly balanced."*

Bulk of Foods in relation to Digestion.

Judged by any of the standards or tests above enumerated or introduced, the Dietaries of this Institution must be considered as *at least ample*. The comparison with other Public Dietaries is decidedly and greatly in our favour; and it would undoubtedly have been so to a still greater extent had the nutritive value of *all* the said Dietaries been estimated by our Standard Table, which, as we have already pointed out, shows a much lower proportion or per centage, especially of nitrogenous components of foods, than the older Tables of a similar kind. Were each patient actually to consume the daily allowance specified as pertaining to or set apart for him, in perhaps a half or three-fourths of the whole population of this Institution the consumpt would greatly exceed the necessities of the system, under the circumstances in which our patients are placed. The result would inevitably be vitiated health, or diseases connected with satiety or excess of food,—a danger which is a real one in certain classes of Public Institutions in an age when it is popularly supposed impossible to *overfeed* the poor—the criminal—the insane.† But, in point of fact, while a few of our patients habitually consume with apparent benefit,—certainly at least with no apparent or obvious detriment,—a larger, sometimes a considerably larger, amount of solid nutriment than that specified as the individual allowance—even the maximum—*for any class* of our community, the majority consume less, frequently not half the

Amplitude of Dietaries of this Institution.

Differences between Regulation Dietaries and actual consumpt of Food.

* Cornhill Magazine, ol. citat. page 290.

† In the Convict Establishment at Freemantle, near Perth, Western Australia, the diet of the prisoners, in 1853, contained a daily allowance per person of 16 oz. fresh meat and 27 oz. bread;—the climate being hot and close,—the exercise insignificant,—the confinement great,—the occupations mostly sedentary. The result was the production of disease attributable or attributed to a diet, which was unnecessarily ample in relation to the requirements of the convicts under such conditions.—*Vide* Dr Rennie on "*Excess* of Diet as a Cause of Disease."—[Roy. Med. & Chirurg. Society of London, June 8, 1858.]

Loss by waste and surplus.

regulation allowance, and equally with benefit or without physical detriment. There is moreover necessarily a considerable loss by surplus or waste, a proportion whereof, however, is replaced or restored in the form of pork,—our refuse food supplying our piggeries. The dietaries of all classes of our inmates are therefore not only ample; but they leave a wide margin after satiation according to the requirements of the systems of the patients, as determined mainly by their appetites.

Advantage of Regulation Dietaries.

The great advantage of such an arrangement is simply the *securing by superabundance or excess a sufficiency of food* of a suitable kind for the mass of the community, some individuals of which consume and require more, others less, than the stated average allowance.

Qualities of Foods.

In regard to the *quality* of the foods composing the dietaries of this Institution, we have to observe that all the articles are of the best kind to be found in the market. They are the same in class and kind as we use in our own household; indeed, in regard to mere market quality they are frequently superior, because we are at liberty to purchase for, and consume, ourselves, articles of diet popularly denominated and deemed "coarse," and correspondingly cheap or inexpensive, which circumstances, already partly explained, unfortunately prevent our supplying to, or causing to be consumed by, our patients.

Purity or fineness not necessarily an advantage.

The articles of diet supplied to the latter are the same in quality and kind as those used by the majority of the middle and upper ranks of society. We have already said so much on the subject, that it is unnecessary here again to insist on the fact that superiority in mere market value is not synonymous with superiority in nutritive value or digestive suitability,—a fact of which the article or item bread perhaps offers one of the most familiar and forcible illustrations.

Occasional superiority of coarse, to fine, foods.

"A good pure "brownish bread," says Dr Brinton, "of simple wheat meal, with even "an admixture of a fourth or fifth of rye, would, for equal money value, "give the labouring population a food incomparably more abundant "and nutritious than that which they now make use of as pure "white bread. And in no way could the dyspeptic affluent set "their poorer neighbours a better dietetic example than by adopting, "were it at some little pains, a bread which might sometimes cure their "own ailments by its mechanical quality, as well as prevent disease "among the lower classes by its nutritive value."* We owe it to the so-called refinements of civilization, that in our staple food, what in a sense we very truly call the "staff of life,"—bread,—we discard the bran of wheat, which is richer in phosphates and other salts than the finer portions of the flour, and which possesses, moreover, mechanical qualities of great importance to healthy nutrition in these days of passive or sedentary lives and occupations.

Brown bread.

* Cornhill Magazine, ol. citat. page 292.

Proportion of Animal to Vegetable Foods.

The extent to which public dietaries should consist of, or contain, animal and vegetable foods, has ever been, and continues to be, the subject of keen discussion. No general conclusion has been arrived at—no general law can perhaps be laid down and acted upon—save this, that, while certain individuals can subsist well or subsist best, under given circumstances, on a purely vegetarian diet, and certain others on a diet nearly altogether of animal origin, there can be no doubt that the bulk of mankind subsist most healthily, as well as economically, on a *mixed* diet:—and that diet exclusively vegetable or animal may, as a general rule, be regarded as unnatural and inadmissible.

Superiority of a Mixed Diet.

The only true principle on which to regulate a dietary is to select the necessary amount and proportion of nitrogenous, carboniferous, and mineral solid nutriment from *both* the animal and vegetable kingdoms. There may be minor chemical or physical differences between the nutrient principles of plants and animals, but they are virtually the same. Caseine, for instance, of the same character as that obtained from milk, can be procured from pease and beans; from which vegetables indeed the ingenious Chinese actually make *cheese*, coagulating the caseine of the seeds by means of rennet.

Animal and Vegetable Foods as mutually substitutional.

Fibrine of the blood and of flesh occurs under the name of gluten in the juices of esculent vegetables, and in the cereal flours; and albumen exists equally in vegetable saps, and in blood and meat-juice. Hence it happens that, under certain circumstances, animal and vegetable foods are mutually substitutional, and in certain others mutually complementary. As a general rule, animal are more easily digested and assimilated than vegetable, foods. This circumstance should lead to a preference of the former class of foods under special circumstances. But science and experience alike point to a judicious combination of both the great classes of foods as yielding the most appropriate diet under ordinary conditions of existence.

Types of Diets.

The best types of simple diets are milk alone, bread alone, or a combination of meat, bread, and butter. These contain the due proportion of nitrogenous, carboniferous, and mineral nutriment intended by nature; and the more closely our composite diets are assimilated to these simple types, the more nutritive, the more easily digestible, the more suitable are they likely, under ordinary circumstances, to be. Meat may be held as representing nitrogenous nutriment; butter, carboniferous; and bread, a combination of both. In so far as the latter contains such a combination in natural and suitable proportions, it alone is, as food, superior in value to meat alone, or butter alone, neither of which would, of itself, suffice to support life.

Bread: as the "Staff of Life."

Bread alone, especially that made from the *whole meal* of wheat, oats, or rye, is at once one of the most economical and most nutritive foods, containing a due proportion of nitrogenous, carboniferous, and mineral nutriment; and as such it is quite capable of supporting life; though neither this nor any other single and unvaried article of diet can long do so in the adult in the best possible way. The extent, however, to which life may occasionally be so sustained, may be gathered from a letter by "One who has followed the Plough," which recently appeared in the *Times*,* in connexion with the consideration of the amount, quality, and cost of food necessary to the bare support of the famishing Lancashire operatives. The writer states that, when a boy, he lived on 2s. a-week, almost his whole food being *bread*,—meat and beer being totally unknown; his only allowance of animal food, a small weekly *taste* of bacon! In so far as the gluten of flour or bread may be considered identical in chemical composition and physiological action with the fibrine of flesh; and fat corresponds similarly to a certain amount of starch, (as 100 : 240) fat meat agrees in composition and action with bread, and may, *pro tanto*, be regarded as substitutional therefor. To be equal in nutritive power or quality to bread, flesh must, however, either be comparatively fat, and at the same time comparatively indigestible or repulsive to many stomachs; or, as is more common in actual diets, it must be associated with some other form of fat, or its equivalent of starch in the shape, for instance, of rice or potatoes—foods which, poor in nitrogenous, are comparatively rich in carboniferous nutriment, and which, as such, constitute admirable adjuncts to a diet chiefly formed of animal foods.

Meat as substitutional for Bread.

Digestibility of Foods:

Given the necessity or desirability to supply a daily average of from 3½ to 5 oz. nitrogenous nutriment to a man, it might be supposed that the readiest and most satisfactory way to do so would be to select a sufficiency in rough weight of the foods richest in this class of nutriment; and the disposition to act upon this idea would perhaps be strengthened by finding that the same kinds of food are among the most economical. Adopting such a principle we should, guided by our Standard Table of nutriment in foods, at once select cheese, pease, and oatmeal,—all of which are unexceptionable articles of diet *in their due place*. A greater amount of solid nutriment is undoubtedly yielded by certain vegetable foods such as pease, or the cereal flours, than by the same weight of most animal foods. Universal experience, however, indicates that no average stomach could digest for any length of time the amount of cheese or pease alone,—in any form of food,—requisite to yield 3½ to 5 oz. nitrogenous nutriment per day, though these substances stand highest in our list or table as regards their nutritive power *per se*. In other words, they are comparatively indigestible—digestible only in moderate quantity; and can be judiciously used

in relation to quantity.

* Jan. 27, 1863.

only in small quantity in combination with, or in addition to, other more digestible, though less nutritive, foods. Hence it happens that foods possessed of greatly inferior nutritive power,—speaking of nutritive power as synonymous with the possession of, or capacity to supply, the greatest amount of solid nutriment, especially of the nitrogenous class,—but endowed with a superior digestibility, are more suitable to the requirements of ordinary stomachs, better fitted to constitute the bulk of ordinary dietaries.

Combinations and intermixtures of Foods.

It would be a repetition to devote separate remarks to any detailed consideration of the necessity for combining and intermixing foods—or of the nature and amount of such combinations and intermixtures. This necessity is determined by, or depends upon, facts already specifically stated or explained, viz.:—that in foods there must be a due proportion between their nitrogenous and carboniferous constituents: that digestibility is of equal importance with mere per centage of nutriment: that no single article of diet, however rich in nutriment, can in the adult adequately, for any length of time, support life under ordinary circumstances. Instinct, long ago, led men to such practical combinations or intermixtures in the form of the habits of associating, in their chief or most substantial meals, such articles or items as beans and bacon, pork and pease-pudding, veal and ham, potatoes and rice with lean meat.

Conventional combinations.

Chemical composition of Foods

Nor is it desirable to recapitulate what we have said under previous heads on the Chemical composition of Foods,—further than to remark that this is a subject worthy of greater attention than is usually devoted to it in the construction of public dietaries and the selection of foods; inasmuch as what appears to be the same food or article of diet, may, from differing in its chemical elements, possess an inferior nutritive, as well as pecuniary, value. Professor Haughton, in his admirable researches on the chemical constitution of foods, and their nutritive power in relation to the capacity of the system for physical labour, remarks that the poor fatty mutton, from 2 to 2½ years old, with pale muscle,—the result of so-called *improved* breeding,—which abounds in the markets of large towns, is very inferior in nutritive value (the inferiority depending on an excess of water and deficiency of nitrogen) to the dark-fibred, lean, apparently ill-favoured, old mutton, 3 to 3½ years old, such as Highland mutton, which in a breeder's or butcher's eyes would probably not for a moment be compared with the other. We can corroborate his statement by our own experience of the comparative digestibility and nutritive value of the very lean, dark-fibred flesh of the sheep of Iceland and the Färoe Islands in contrast with the mutton common in the markets of Edinburgh or London.

In relation to quality.

Superiority of lean to fat Mutton.

Variety in Foods.

The experience of athletes, boxers, wrestlers, and pedestrians—of the "trainers" of race horses and fighting cocks—shows that the most vigorous health cannot long be maintained on a uniform diet, however nutritious and substantial this may in itself be: and how necessary therefore in the selection of foods is *variety*. Such is the importance of variety, as an element in diet, that foods inferior in nutritive value

Co-existence with Economy.

are frequently superior in usefulness or suitableness, simply because a greater and more judicious variety is supplied. Fortunately, it frequently happens also that greater variety is not necessarily synonymous with greater expensiveness; on the contrary, the more varied diet may be the more economical, as well as the more palatable and digestible. Hence it is desirable, within due limits, to vary the diet in a public institution from day to day, so that no special food or article of diet may be suffered to pall upon the appetite on account of its uniformity. This can be readily done without any increased expenditure by the substitution, for instance of fish, poultry, rabbits, ham, bacon, or game, for ordinary butcher meat: of rye, oats, or barley, lentils, or revalenta, for the more common cereal and leguminous flours: of rolls, biscuits, scones, or cakes, for the more usual forms of bread: of puddings, stews and hashes for soups and broths. By this means we secure that foods are palatable, or relished; and it is by no means unimportant that such a relish should both be

Causes of Variation.

created and attended to. In the light of the remarks that have already been made on the chemistry and physiology of Food, it is obvious that diet should vary with the varying circumstances of its consumer, in regard, for instance, to the kind and amount of his physical labour

Season: in relation to Diet.

and exercise. It is no less evident that it should vary materially with external temperature—with the seasons; a more substantial diet being called for in winter than in summer—one abounding more in meat and fat—more strictly animal in its origin in the one case—more properly or purely vegetarian in the other.

Modifications of Food by Cookery.

Marvellous are the modifications produced on the same foods by the resources of modern culinary art. Not only may the same amount of raw material be rendered more savoury and palatable,—in itself a matter of some moment; more easily digested and assimilated,—a matter of still greater moment; but it may be made to yield a much greater amount of nutriment by proper cooking, which, as a question both of economy and physiology, is of the highest importance.

Defects of Culinary Art.

Equally marvellous, however, it is, that cookery, in relation to dietetics in our public Institutions, is most defective; the result whereof is not only great loss of material, but great physiological errors. How zealously, for instance, do cooks throw away, as useless, the water in

which vegetables have been boiled,—a solution, to wit, of mineral nutriment essential to healthy nutrition, especially to the upbuilding of the more solid framework of the body—salts, which must, if lost

Popular prejudices and errors in Cookery.

in this the most natural form in which they could be presented, be supplied in some other, probably more expensive, shape. Dr Noad found that water, in which 1 lb. of potatoes had been boiled, contained 17 grains of carbonate of potash; and that, in which an equal quantity

Waste of Mineral Nutriment.

of cabbage had been boiled, 21 grains of sulphate of potash; and we would only refer to our previous remarks under the head of the mineral constituents of Food, (page 34) to indicate the importance of the *potash* salts alone in the economy. The same salts occur, in varying proportions, in turnips, carrots, and other vegetables; hence the water in which these have been boiled should, in the hands of a careful cook, be retained as the basis of soups or some other form of food. A parallel waste of mineral nutriment occurs in the loss occasioned by the salting or pickling of meat. This causes the expulsion of a great part of the meat-juice and blood, with their salts; so that in order to avoid the total loss of these salts, and of the other forms of nutriment which such juices contain, the latter should be carefully preserved and used as sauce, soup, or in some equally convenient shape. Otherwise an equivalent must be supplied, and this may most readily be found in concentrated meat-extracts, essences, or juices; or, *quoad* simply the salts, in green vegetables, which contain 10 to 20 per cent. of their weight of saline or mineral matter. Much loss is suffered by ignorance in the apparently simple process of cooking Meat.

Cooking of meat:

Of all processes for preparing it for table, so as to retain in it the greatest amount of nutriment in the most savoury and most easily digestible shape, none is comparable with roasting.

Its rationale.

By this process the albumen of the juice of the surface of the meat is at once coagulated, and a crust is thus formed, which retains the more central nutrient juices. On the other hand, the worst of all such processes, *quoad* the meat, is the "boiling to rags," customary in the manufacture of beef-tea. With a view to the production of the most nutritive beef-tea or *soup*, the proper solvent of the juices and salts of meat is *cold* water gradually heated to boiling; but if the *meat* be intended for use in the boiled form, it should be at once thrown into *boiling* water, whereby, as in the analogous case of roasting, heat is applied to the surface, and the surface albuminous juices coagulated at once.

Quality of water used in Cookery.

The quality of the water even, which forms the basis of so large a portion of our food, is little considered; whereas the softer and purer the solvent menstruum, the greater will be the amount of soluble material dissolved—of nutriment yielded in proportion to the quantity of food supplied. But the quality of water is of much greater importance than this aspect of its uses indicates; for, independently of their inferior solvent powers, waters containing certain proportions and kinds of salts or organic matter, exert, in virtue thereof, a most deleterious action on the economy, giving rise to several series of dangerous or fatal diseases. Modern cookery is, however, not only blameable in the directions pointed out, but in certain other forms or directions, the results whereof are equally serious, both in view of

Fallacious Nutritiveness.

loss of material, and danger to health or physical vigour. It has unfortunately the power or means, by its most varied resources and ingenious devices, of bestowing upon certain classes of foods the appearance of the possession of qualities in which they are really deficient. We allude, for instance, to the whole starch family, in association, perhaps, with the gelatigenous series; to arrow-root, sago, tapioca,—to calves' feet, and other jellies or glutinous soups,—wherefrom the modern cook can fashion an infinitude of most elegant and attractive

Starchy and Gelatigenous Foods.

dishes. When these are regarded strictly as elegancies and adjuncts,—as non-nutritive in the scientific sense,—there can be no objection to their use within reasonable limits. But it is a great error to suppose such foods possessed of "strengthening" qualities,—if thereby we mean that they are capable of yielding solid nutriment—and to make use of them, to any extent, in lieu of bread and meat—the staples of substantial diet. On this subject, Dr Edward Smith, an eminent

Arrow-root Type.

authority already quoted, remarks:—"The practise of administering "arrow-root, or other fashionable foods, consisting of starch with water, "under the impression that it was more nutritious and easier of assi-"milation than wheat flour, was indefensible; since it did not sustain "the vital action to a degree capable of maintaining life, and since "nature has not provided starch as food, altogether apart from nitro-"genous substances."*

Serving of Meals.

Intimately connected with the mode of cooking food is the mode of serving it; and the latter includes a consideration of the character of table-furnishings, a subject to which, so far as this Institution is

Æsthetics of the Table.

concerned, we have before alluded (pages 19–20). The Æsthetics of the Table are by no means contemptible in their relation to the function of digestion. Though their influence is undoubtedly psychical and not physical, in the first instance, there can be little doubt, we think, that forms of beauty communicated to the vessels in which food is served, and to the instruments with which it is consumed, minister in an appreciable sense and degree to the pleasures of food-taking: and whatever contributes to these pleasures—to the zest for meals—to the facilities of digestion—is worthy of regard. Fortunately, modern art

* "Practical Deductions from an Experimental Inquiry into the Influence of Food."—Royal Med. and Chirurg. Society of London: May 10, 1859.

Applications of Modern Art to Table Furnishings.

is so prolific in materials and devices—it supplies elegancies, which do not suffer in their usefulness, at such a cost—as to render it no great sacrifice, or involve no large expenditure, to supply the most beautiful creations, for instance, of ceramic art instead of the clumsy bedaubed pottery of a byegone age; the most elegant furnishings in various composite metals, such as nickel silver, german silver, Britannia metal, aluminium, and aluminium bronze, instead of the heavy, equally expensive pewter goods: the most chaste designs in glass and crystal for the plainest articles in horn, tin, or crockery: the best productions of Sheffield and Birmingham for antiquated horn spoons, bone knives and forks, or for still more unsophisticated instruments—the human fingers.

Accessory Foods.

The universal experience of mankind, in all ages and countries—in all circumstances of life, savage and civilised—indicates the desirability of aiding the digestion of the more substantial and nutritive articles of food by certain accessories (stimulant or calmative alkaloids, such as those of tea, coffee, or cocoa—malt liquors, wines, and spirits—and condiments,) to which we cannot at present devote adequate consideration.

Dietetic Medicines: their place and power.

If the physiology of foods proper is still in an unsatisfactory state in a scientific point of view, still more so is the physiology of stimulants and condiments, or other classes of dietetic medicines. "The "importance of special portions of our food," says a Reviewer from whom we have had already occasion to quote, "cannot be estimated "merely by the value of their *direct* contribution to the system." . . . . "The addition of ½ pint of milk a-day to the diet "at Wakefield gaol, in 1853, diminished the sick list from 22 to 14 "per cent.—an effect much beyond that which could be attributed "to the amount of nourishment contained in the milk." *

Peculiarities of the Individual in relation to Diet.

A diet may be in all respects in itself unexceptionable: its quantity, quality, variety, digestibility—its mode of cooking and serving may be all that could be desired, and yet it may be unsuited to the nutrition of the individual recipient, from circumstances in, or connected with him, which have escaped our consideration. There are qualities or conditions of the consumer that are quite as important as those of the diet provided; and to these it is now necessary to give some measure of attention before drawing certain general conclusions, and thereby quitting the subject of Asylum Dietetics. In relation to the digestion of the same foods, it is notorious that there are great differences between men of the same age and class, living apparently under precisely similar conditions. Some can be maintained in health and vigour only on continual abundance of substantial foods; while others, under similar circumstances, are sufficiently fed on light meagre diet—in whom such

* Cornhill Magazine, ol. citat., page 283.

diet alone is popularly said to "agree with their constitution." Not only, however, do different persons differ remarkably; but the same person differs as much from himself, under different circumstances, from time to time, as he does from others. So great are such differences—so familiar and conspicuous in relation to diet that they have become, ages ago, embodied in the proverb—"What is "one man's meat is another man's poison." Hence, in relation to diet, it becomes as necessary to study the peculiarities of the consumer as of the diet: there must be a mutual adaptation. Individualization of Dietetic, is therefore quite as necessary as of Medicinal, treatment: there must be special provision, after special study, for the wants of each individual case. This is the only safe and scientific way of regulating either diet or medicine,—for to be efficient all such regulations must be personal or individual. It follows from what we have just said that no Regulation Dietaries can be equally suitable in the case of every individual in any class or body of men. Indeed, in this view, public diet tables are scientific absurdities; and the chief benefit they confer, as we have already pointed out, is the securing of *suf*ficiency, if not *ef*ficiency, by providing a superabundance of food,—a quantity and kind, to wit, theoretically suitable for the adequate nutrition of healthy adults. If the individualization principle of treatment must be acted on in regulating the dietaries of the sane, it becomes infinitely more important and necessary among the insane, in whom there are so many additional circumstances or causes interfering with the normal physiological action of ordinary foods,—in whom the incessant disturbances of nervous influence, modifying the function of digestion, alone call for equally numerous modifications of diet.

Principle of Individualization in Dietetic Treatment.

Physical health as a modifier of Digestive capacity.

Perhaps the most prominent cause of modification of diet in relation to the requirements or capacity of the consumer, in such a community as ours, is to be found in the peculiarities of the physical and mental condition of, the nature and proportion of physical and mental disease in, our population. Of persons *apparently* in good physical condition, whose appetite appears unimpaired by confinement, and who seem to eat, in proportion to their work and exercise, as much as they would probably do if sane and free, there are about 60 per cent. of the males, and 50 of the females,—or 55 per cent. of both sexes. Many of these persons, however, are well advanced in years, and their appetites and requirements demand a proportionably diminished allowance of food—our scales of diet being all adapted for able-bodied *adults* in the vigour of life. On the other hand, about 40 per cent. of the males and 50 per cent. of the females, or 45 per cent. of both sexes, bear the marks of depraved health. They are naturally of delicate

Prevalence of infirmity or disease in our Community.

constitution and slim build, with a languid circulation and little activity of vitality; or a naturally good constitution has been undermined by dyspepsia, by age or by the other causes of impairment immediately to be considered. About 15 per cent. of the male patients, and 25 of the female, or 20 per cent. of both sexes, are positively infirm. This category includes the bed-ridden, the paralytic, the inmates of the infirmary wards or sick rooms, the feeble and helpless from age. The tables appended to this and previous reports, in connection with the admissions, illustrative of the co-existent physical diseases or injuries—the vitiated conditions of general health—of patients received, point out the following as among the commonest physical complications of insanity:—

Infirmity or Disease co-existent with Insanity on Admission.

1. Anæmia, chlorosis, or other cachexiæ.
2. Emaciation and debility, sometimes extreme, produced by, or resulting from *a*. Prolonged abstinence from food.
   b. Masturbation, or debauchery.
   c. Intemperance.
   d. Parturition and lactation.
   e. Previous fevers or other exhausting diseases.
3. Pulmonary affections, more especially bronchitis and phthisis.
4. Gastric disorders, especially dyspepsia and gastritis, sub-acute or chronic, with frequently chronic vomiting and inanition.
5. Cutaneous affections, generally of a chronic and inveterate character, such as psoriasis, eczema, and acné.
6. Intestinal disorders, especially constipation and diarrhœa.
7. Paralysis—simple and usually local—such as paraplegia: or, the special form denominated General Paralysis or Paresis.
8. Heart affections—functional and organic.
9. Rheumatism, especially of a chronic kind, including rheumatic gout.
10. Ulcers, abscesses, boils, and carbuncles.
11. Wounds or injuries—suicidal or accidental—interfering with exercise and occupation, or threatening life.
12. Catamenial irregularities or uterine and vaginal affections, such as amenorrhœa, leucorrhœa, dysmenorrhœa, and menorrhagia.
13. Ophthalmia Tarsi and other indications of the strumous diathesis: while more rarely there are such affections or conditions as
14. Pregnancy, hernia, bronchocele, hæmorrhoids, &c.

We may take a different view of the same subject, the vitiated vitality of a large proportion of our population, through the medium of illustrations of the classes of minor ailments to which our residents are subject. The table given in our 34th Report (1861, page 101 et seq.) refers to a year, which was exceptional *quoad* external temperature, the excessive moisture of the atmosphere and other meteorological conditions, as well as the overcrowding of the inmates and other unfavourable sanitary arrangements. Though the number of affections therein tabulated is certainly correspondingly exceptional, their kind or type does not differ materially from that which characterises the general health of our community during every year and every season, though more particularly the winter season. In the order of their general frequency, the minor ailments to which our community is liable may be thus classified:—

Prevalent Morbid conditions of Health.

1. Boils and allied affections, including whitlows, abscesses, carbuncles.
2. Diarrhœa, usually simple.
3. Catarrhs and allied pulmonary affections, especially bronchitis.
4. Ulcers, including onychia, &c.
5. Cutaneous eruptions: psoriasis, eczema, impetigo, rupia.
6. Miscellaneous affections—including erythema and erysipelas, congestive apoplexy, purpura, strumous corneitis and conjunctivitis, cynanche tonsillaris and parotidea, rheumatism, &c.

Additional data for the formation of an estimate of the state of our community in regard to physical health may be gleaned from our remarks in a previous part of this report (pp. 9–10) on the mortality of the year, and on the cases requiring the use of special surgical appliances or the assistance of surgical experts. Certain of the affections prevalent among our residents are direct derangements of the function of nutrition—specific disorders, organic or functional, of the stomach and intestines. But the tendency or result of all classes of ailments—major and minor—referred to is to deteriorate and depress the physiological activity of the general nervous system; and, whatever does this implicates or reacts on the important and delicate function of digestion and assimilation, as well as on every other function of the economy. The biological conditions produced by disease differ materially from those, which are the result or expression of health: neither food nor medicine, it is notorious, act in the same way on the sick as on the healthy. Hence these biological conditions, in relation to diet, must become, with the judicious physician, the subject of special study *in every individual case*. With so large a proportion of infirm or debilitated, diseased, or dying patients, our *actual* Dietaries must deviate largely from the Scales or Tables already given, and which

Derangements of Digestive System.

Depressed nervous energy.

are altogether adapted to the healthy and strong. Hence a considerable number of our dietaries are equivalent to the "Low," "Rice," and other diets of the Edinburgh Royal Infirmary, whereof panado, or the farinacea and milk constitute the type, bulk, or basis. While, in respect of solid nutriment, there is in such cases a large subtraction from the quantities specified in our Printed Dietary Tables, there is a considerable and frequently an expensive addition in the form of Dietetic medicines, such as wines and spirits, porter, tea, coffee, &c.

Sick Dietaries.

Not less important perhaps than the physical, is the mental, condition of such a community as ours in relation to its food. Digestive difficulties probably as frequently arise from the state of the brain as from that of the stomach or the food. Among the healthy sane, it is too familiar to require exposition or demonstration here how easily and materially digestion is affected or perverted by simple emotional disturbances: by mental exhaustion,—business cares,—family disquietudes,—by the general mental condition implied by such expressive terms as "worry," "anxiety," "weariness of spirit." How suddenly and frequently do we all see capricious appetite, or depraved appetite, or want of appetite result from the simplest emotional causes: phenomena indeed which are among the most common and striking examples of the "Influence of the mind over the body." There is perhaps no single greater enemy to healthy digestion than *Mental Anxiety*, not only on account of the impairment of the function of innervation directly, and of nutrition indirectly, thereby produced, but from its importance as a direct destroyer or waster of tissue. Professor Haughton found mental anxiety more exhaustive of tissue as well as of physical energy, than either physical or mental work. So destructive indeed is its influence that he speaks of it as "that most "fatal of all diseases to which man is liable—anxiety of mind—a "vague and unscientific expression, which, however, denotes a most "real disease."* If then it be the case that, among the sane, digestive derangement, and with it an incapacity to assimilate certain kinds or amount of food result from mental causes or nervous influences of a slight and transient kind; how likely is it that such derangement to a greater extent—that digestion and assimilation still more depraved in character should be the rule and not the exception among the insane, where it may be presumed there is a disturbance of the dynamical equilibrium of the brain and general nervous system, the physiological actions or functions whereof are depressed or excited, perverted or interfered with in so many forms and degrees. Some forms and phases of insanity are intimately associated with, and may even in some cases be said to be characterised by, peculiarities of

Mental changes in relation to Digestion.

Mental Anxiety.

Insanity in relation to Nutrition.

Peculiarities of the Insane as to Food.

* "Natural Constants of the healthy Urine of Man," ol. citat., page 34.

appetite, digestion, and assimilation. There are few peculiarities of the insane more familiar, and at the same time, more troublesome, the sources of greater anxiety to the physician, than the anorexia, or obstinate refusal of food frequently associated with melancholia and certain kinds of monomania; while over against those, we may set as a *per contra* the apparently faultless appetite and easy digestion of happy dementia. In every asylum are to be found patients who habitually regurgitate or ruminate their food, or who deliberately vomit it: who consume, whenever an opportunity is afforded, grass or every species of offal,—or still worse, fæces and matters equally disgusting: who "bolt" their meals, not masticating sufficiently, or not masticating at all: who can supply no natural materials for insalivation by reason of the noxious habit of incessant spitting: who have endless appetital caprices connected with delusions, frequently as to the supposed poisoning of food or adulterations thereof: who, for long periods, from persistent refusal of nourishment, require a resort to artificial alimentation, which admits of the introduction into the system only of certain classes and amounts of food—the digestion and assimilation of which cannot usually be secured by the necessary exercise or other customary and efficient aids or complements to digestion. In all such cases it must be evident that the diet proper for a healthy sane adult must be unsuitable or improper; either insofar as it is not the most readily digestible under the circumstances, or it cannot be administered or supplied in its ordinary form, or it is supplied in excess of the capacity or requirements of the system, whence waste or disease results. In this view, again, the food-supply of our Printed Diet Scales must appear superabundant for the average wants of the community.

Confinement in relation to Diet.

Nor must we forget, in considering the effect of mental disease on appetite and digestion, the influence of that department of the treatment of insanity which consists in confinement. In the parallel case of prisoners, Dr Edward Smith found that the power of assimilation is lessened by confinement; and this, if equally correct in regard to the inmates of asylums, would imply the expediency of specially adapting the dietaries of the latter to their diminished assimilative capacity.

Exercise in relation to Diet.

But not only does the physical and mental condition of the insane directly modify the function of nutrition and call for corresponding modifications in their diet; it does so also indirectly, by limiting or determining the nature and amount of their exercise and occupations. No system of dietetics—no kind of dietary—no scale of food—is complete or satisfactory, which does not include, or with which is not associated, with a view to healthy digestion, a sufficiency of exercise in the open-air. Muscular exercise is indeed indispensable to vital

vigour: there is nothing that can be substituted for it. Without it there is not the same healthy removal, and reconstruction or replacement, of tissue. So essential is it to digestion and thereby to nutrition and to health, that we regard it as an essential complement to, if not an integral part of, diet; and as such, we prescribe and enforce it quite as systematically as we do medicine.

Exercise an integral part of Regimen.

In such an Institution as this, exercise constitutes a most important feature of treatment—our efforts being generally quite as much directed to the restoration of a normal digestion as to the treatment of mere mental phenomena, so frequently springing from, or inseparably connected with, a diseased innervation and nutrition.

Systematised exercise.

The active industrial occupations of a certain proportion of our community may be held as implying or involving a sufficiency of muscular exercise: and doubtless, in most cases, they do so.

Associated with Occupation or Recreation.

But even in these cases we secure an additional amount and form of muscular exertion by walks, games—such as foot-ball and cricket—and other forms of pure exercise, or of exercise associated with recreation. About 45 per cent. of the male patients, and 70 of the females, or about 57 per cent. of both sexes, who do not engage in occupations involving physical exertion, or who do not usefully occupy themselves at all, are yet made to take a sufficiency of open-air exercise, in the form mainly of walks in the grounds or beyond them—or of games and recreations—such exercise or recreations necessarily varying both in degree and nature with the condition—physical and mental—of the individual.

Difficulties in compulsory Exercise.

A small per centage of patients obstinately and absolutely refuse open-air exercise of any kind, and its compulsion might lead to consequences, to themselves and others, of a very serious kind. In a large proportion of cases there are great difficulties connected with the compulsion or enforcement of exercise, just as happens in the parallel cases of food and medicine. But these difficulties are in all, save a fraction of cases, ultimately satisfactorily overcome; and in the vast majority of the patients exercise is secured, sufficient in kind and amount for the requirements of the system *quoad* the digestion of Foods.

Muscular hyperactivity as a feature of Insanity.

In about 10 per cent. of both sexes, the form or character of the mental disease secures or implies not only a sufficiency, but a superabundance, of muscular action, an excess creative of exhaustion, sometimes of an extreme and fatal kind, requiring as sedulously to be checked, as in other cases, muscular action must be encouraged. Such cases are usually found in various forms of restless Mania.

Occupation in relation to Diet.

Not less important, in its relation to digestion, than exercise is the nature and amount of occupation,—especially such as belongs to the category of physical labour in the open-air. Such labour involves

Muscular or Mechanical Labour.

the muscular action requisite for the due aëration of the blood; the proper oxidation of carboniferous foods; the healthy removal and replacement by nitrogenous nutriment of tissue-waste. It supplies, moreover, a healthy mental stimulus, which reacts most favourably on the general physical condition, and thereby on all the functions of the economy. Great physical exertion or labour is a large consumer of oxygen, a large destroyer of tissue, and it demands in consequence a liberal supply of carboniferous and nitrogenous foods:—to what extent in comparison with the requirements of the inactive or idle may be seen on reference to Dr Letheby's Table in the Appendix.

Mental Labour.

Mental work, however, produces the same expenditure of force and substance as severe bodily labour; and it therefore calls for a correspondingly large supply of food to replace the great waste involved. But there is wanting the same healthy and rapid reconstruction, after removal, of tissue, which muscular exercise or action alone can give rise to; and unless such exercise be added in some form to an adequate extent, digestion and nutrition will infallibly suffer. Indeed, in the majority of cases, from inattention to this circumstance,—to the necessities of the system for muscular action,—digestion and nutrition do suffer and suffer materially,—too frequently irremediably—in the mere brain-worker.

Comparative waste of tissue under Muscular and Mental Labour.

The amount of bodily or mental work is measurable by the daily waste of tissue in the economy; and this daily waste by the quantity of urea excreted *per vesicam*. Estimating by this means their relative influence as factors of tissue-waste, Professor Haughton found that, while ordinary mechanical or muscular labour produces per day an excretion of 136·5 grains of urea; mental work, in the form of 5 hours' study, gives rise to 217·0 grains; and in the form of 8 hours' ordinary office or routine work to 221·7 grains. There is thus a waste of tissue generated by mental work superior in degree or amount to that produced by the same duration or equivalent of mechanical or muscular work; and the inequality is infinitely greater when mental work becomes more intense, or when, above all, mental "worry" or anxiety is super-added. Hence it happens that, measured in this way, the clerk at his desk, or the student in his retirement, may, within an equal space of time, do quite as much work—expend as much force and waste as much substance as the Crimean navvy or the Yorkshire labourer.

Different qualities of Foods required by the Hand-worker and the Brain-worker.

But it is evident that the position of the one class of workers is very different from that of the others in relation to the amount and quality of their foods,—the normality of their digestion and nutrition. The muscular exercise in the one series of cases and its absence in the other; the muscular expenditure or loss in the one, the nervous waste in the other—make the difference a most material one. Given, let us suppose, the same tissue-waste by muscular and by mental work and an equal need of reconstruction or replacement by nutritious foods; the quality and amount of food in the case of the mechanical labourer must differ materially from what it will be in the case of the brain-worker. In the latter the food, even if of equal amount as to its proportion of solid nutriment, must be of different quality, as to digestibility: his digestive and assimilative powers are feeble—his whole vitality comparatively depressed and languid. Hence while the brawny son of toil,—the field labourer, who passes the bulk of his life actively employed in the open-air, and whose physical exhaustion is followed by sound and restorative repose,—can digest with ease, and maintain life and health in their highest vigour on such foods as pease and oat-meal, cheese, fat meat, and vegetables: the care-worn student, whose exercises are scarcely at all of a physical or muscular character, and are mainly confined within the four walls of his "sanctum" or library, whose nervous exhaustion is generative of a nervous irritability and excitement, preventive of sound sleep, can only digest—and that probably with difficulty—such simple foods as milk, eggs, lean meat, and the farinacea. All this has an intimate bearing on diet and digestion among the insane; for while comparatively few of them are in the position of the field labourer, as above sketched, too many are in the position of the care-oppressed student—their nervous system shattered or debilitated by mental anxieties or emotions, or by the thousand so-called moral and physical causes of insanity to be found tabulated or set forth in the reports of all our public lunatic asylums. Applying these remarks to our own community, it is obvious that our dietaries or diets—with a view to the healthy nutrition, to the physiological requirements, of the individual, should vary—both as to the nature and amount of the foods composing them—with the nature and amount of his occupation, —with the extent to which his work, his recreations, his exercise partake of a muscular or mental character—with the healthy or abnormal tone of his innervation.

Different kinds of Foods required by different classes of Patients.

The healthy male adult, originally a field labourer,—who spends from 6 to 10 hours a-day in garden trenching; the sturdy Irish girl, originally a potato-gatherer, who spends nearly an equal amount of time over the laundry-tub; the excitable maniac, whose supe abundant muscular and nervous activity are directed upon the routine, but pretty severe, operation of pumping water; the healthy monomaniac, who, in the form of pacing or walking exercise in the airing-courts, verandahs or grounds, expends an amount of muscular activity equal to that implied in at least 20 miles per day of pedestrianism—must evidently be very differently treated, as to diet, from the feeble, anæmic, emaciated, phthisical melancholiac; or the chlorotic subject of amenorrhœa and hysteria; or the helpless bed-ridden paralytic, aged or dying; or the abstinent, the regurgitators, the vomiters, the dyspeptic; or the professional man, originally endowed with a peculiarly sensitive nervous organisation, whose mind and nervous system have been irremediably damaged by the extreme and prolonged mental tension of anxious office, who is unsuited on the one hand, and disinclined, on the other, for physical occupation or exercise, and whose recreations are all of a sedentary class; or the proud mono-maniac, who disdains manual labour as infinitely degrading, and lives a life of inglorious ease and sloth. In this aspect, again, individualization of treatment becomes essential; the peculiarities of each individual must be studied,—his requirements prescribed for,—whether in regard to food or medicine, exercise or occupation.

Proportion of Patients industrially employed.

About 35 per cent. of the male Patients, and 20 of the female, or 27 per cent. of both sexes, are usually or habitually engaged in active industrial occupations. These comprise among the males the out-door labours of the garden and grounds,—of the farm-yard and parks,—as well as the more confined operations of pumping water, or gallery-cleaning, and the systematic industries of the workshop. Among the females they include laundry, kitchen, gallery, and workshop operations, all of which are mainly of an in-door character. But many of the Patients belonging to this category—industrially employed—are so to a very limited extent; the extent or amount, as well as the nature, of their occupations being altogether determined by their physical ability. A considerable number are up in years and feeble in energy, and are only able for mild forms of simple or routine mechanical duties.

Work as a feature of curative Treatment.

Further, as we have already explained, it is no object of ours to exhibit the largest possible per centage of labouring Patients,—the highest development of industrial occupation, save insofar as this may be an accidental expression of the physical vigour of our community. Work is prescribed simply as an integral part or feature of treatment,—only where it is considered conducive towards restoration to mental and physical health.

Sedentary occupations.

In about 10 per cent. of the males and 35 per cent. of the females, or 22 per cent. of both sexes, occupations are sedentary, implying little or no muscular or mechanical exercise or action; but such occupations are most beneficial, insofar as they pleasantly and profitably engage the mind.

Recreational occupations.

This category includes pure amusements,—such as music; as well as those which combine instruction and recreation, such as most kinds of reading. The games, in which a large proportion of the Patients, especially of the higher classes, join, are more useful, insofar as in dancing, foot-ball, cricket, archery, and

bowls, a considerable amount of pleasant muscular exercise is involved.

Proportion of the Idle.

About 30 per cent. of either sex are altogether and persistently idle and apathetic—so far as concerns any species of regular and useful occupation.

Idiosyncrasies in relation to Diet.

Due cognizance must also be taken of individual idiosyncrasies, both those which are healthy or physiological, innate or congenital, permanent and persistent, and those which are morbid and acquired, transient and accidental. That natural and congenital idiosyncrasies materially affect diet and digestion may be illustrated by the very familiar fact of the production of Urticaria, or still more serious or disagreeable results, by the ingestion by particular persons of particular foods and fruits. In such a case pre-eminently "What is one man's meat is another man's poison;" for an article of diet, such as second-quality flour, which is most nutritious and most wholesome in itself, and which is palatable to, and easily digested by, the great bulk of his fellow countrymen, may act as a poison on the unfortunate individual who is the subject of this peculiar predisposition or idiosyncrasy.

Quality of Nervous Organisation.

There are differences in the quality and character of the nervous organisation, that determine those susceptibilities to certain classes of healthy or diseased action, which characterise individuals, and which may be said indeed to distinguish every individual from every other individual. The nervous sensibility or irritability, using these terms in a physiological sense, differs as greatly in different classes of men as between different breeds of the lower animals; and a full consideration of these differences in the latter—where they have become the subject of direct experiment—might lead to a more thorough understanding of those in man.

Idiosyncrasies in the Lower Animals as illustrative of those in Man.

Professor Claude Bernard of Paris, one of the most eminent living experimental Physiologists, in his excellent Lectures on "Idiosyncrasies in Animals,"* remarks as the result of long observation that, while the higher breeds of dogs are endowed with such extreme sensitiveness and such an amount of nervous irritability, (using all these terms in a strictly physiological sense), or are characterised by what in a similar sense may be denominated "nervousness" to such extent, that the slightest operation induces fever and materially interferes with every function of the economy, beginning with digestion and nutrition:—the lower breeds are characterised by such a degree of bodily endurance and hardihood, by so much greater obtuseness of function, by so much less exquisite a nervous sensibility, that the same operations elicit scarcely any pain;

Differences in Nervous organisation produced by artificial creation of Breed in Animals.

"the animal hardly attempts to "move and scarcely seems to suffer: the appetite remains unimpaired "and the secretions normal; in short, the various functions of "the economy *pursue their natural course.*" † Equally great

* "Medical Times and Gazette," February 4, 1860, page 109.
† *Ibid* page 110.

Dog and Horse.

are these differences, as the direct effect of breeding, in the horse. "An irritable, sensitive, and highly organised nervous system is, in fact, "the essential difference, which separates the Race-horse from one of "these diminutive half-wild ponies, which hilly countries so abund-"antly produce." Now the results of civilisation in man are analogous to those of breeding in animals; and we may properly compare, or class—*quoad* the quality or character of their innervation—the higher ranks of society in this country, more especially the brain-workers, with the higher breeds of such animals as the dog and horse; and the lower ranks, the muscle-workers, with the lower breeds. We are characterised at the present day—as the result of our civilisation, the artificialities and abnormalities of our lives—by a prevalent irritability of constitution, depending on the quality of our nervous organisation, which, as it affects diet, renders necessary—speaking generally and alluding especially to the brain-working classes—a smaller amount of solid nutriment and a proportionably large consumpt of pure stimulants or of fluids of the class of Dietetic medicines. Physicians abundantly recognise this peculiarity of constitution in the altered "type of disease," in its more asthenic or typhoid character, in the little tolerance of, or requirement for, "heroic practice" such as depletion and the administration of powerful antiphlogistics and depressants; and on the other hand, the necessity for stimulants, tonics, and nutrients.

Analogy, *quoad* results, between Creation of Breed and Civilisation.

Prevalent Nervous Irritability in relation to Diet.

Under certain circumstances, appetite, craving, desire, relish, or liking for particular kinds of food may be regarded as the expression of a healthy want, and as such they should become valuable guides in the adaptation of diet to the individual. Dislikes for food in general, or for particular kinds thereof, frequently, as in the case of the sick, indicate defective digestive and assimilative power or capacity; and in such circumstances the only procedure that is judicious, or perhaps that is admissible, is to substitute smaller quantities of food of the most easily digestible kinds, and to render them as palatable and savoury as possible. Dr Edward Smith makes the following apposite remarks, as the result of a long series of elaborate experiments on the Physiology of Foods—the most complete of their kind recently made or published. "In my inquiries I found that, with a disrelish for an "article of food, there was less influence from it than under ordinary "circumstances. . . . . . . It is, therefore, questionable how "far it is proper to induce a person to take that which he disrelishes. "An important meaning is shown to exist in that, which is commonly "regarded as irrational or capricious." . . . . And the Cornhill reviewer, following the same line of argument, observes, "What is most

Appetite or Relish as a Guide to selection of Food.

Dislike or Disrelish indicative of defective digestive capacity.

"relished is, at once, most needed by us, and best digested. . . . "The sick man's longings are the physician's sign posts." . . . . That therefore would appear to be "The best diet, which gives the "most genuine and permanent satisfaction."* There are, again, certain other appetites and longings, relishes and likings of a decidedly morbid character and origin, which demand a very different treatment. In every asylum there are many patients, whose appetite is inordinate or depraved, or both; they devour greedily, whenever opportunity occurs, the most indigestible and filthy substances—including grass, fæces, and other garbage—thereby destroying the healthy tone of the stomach, and vitiating the whole process of digestion and nutrition. About 10 per cent. of the male Patients in this Institution, and 7 per cent. of the females, or 8 per cent. of both sexes exhibit appetites either simply inordinate, or depraved and capricious, or both; such morbid appetites being characteristic features or concomitants of the forms or phases of mental disease of which they are the subjects.

Morbid Appetites.

All the foregoing Dietetic considerations, statistics and calculations lead to the conclusion, to which every stage of this inquiry has equally brought us,—that Dietetic treatment, to be efficient, must be *individual*. Science and experience alike prove this, and show that no Regulation Dietary, table or scale, however complete and satisfactory in itself, however skilfully drawn up, can be equally adapted to *all* the individuals of any body, class, or community, who necessarily differ in respect of constitution and idiosyncrasy, health and disease, occupation and exercise. Hence, while it is perhaps necessary or expedient that a Public Hospital—such as this—should possess some full Standard Dietary Scale for all classes of its inmates, it would be most unwise to regulate the consumpt of each individual by any such arbitrary standard. Variation is necessary, infinite in proportion to the infinite variety in the peculiar circumstances of individual patients. To what extent, or in what form, such variations occur in the practical dieting of the inmates of this Institution our printed Diet Tables do not at all, and indeed cannot, show Nor is it possible fully to exhibit them save by such illustrations as the aggregate cost of extra diet for a particular class of Patients—for instance that of paupers. A large proportion of this class of inmates,—in virtue, or by reason, of their physical or mental condition,—their idiosyncrasies,—their age,—have a diet quite as good,—in every sense at least in which it can properly be considered good,—as that of the highest classes of Patients. This can only be secured at comparative expense: inasmuch as the wines and spirits, porter and ales, tea and coffee, eggs, arrow root, sago, tapioca, Indian corn, and other so-called and considered luxuries, which are

Principle of Individualisation in Dietetic Treatment.

Difference between Regulation Dietaries and actual consumpt.

Variations of Diet with peculiarities of Individual.

Dietetic Luxuries for Paupers.

* "Cornhill Magazine," ol. citat. pp. 283-4.

freely supplied, are greatly more costly than the oat-meal, which constitutes the basis or type of the diet of the ordinary pauper. The liberal views and instructions of the Directors have, however, invariably enabled us to bring Dietetic treatment, in common with every other class or kind of treatment, to bear *firstly* and mainly upon the

Fitness a superior consideration to cost:

physical and mental improvement of the individual Patient—and to regard the pecuniary relation of such measures or treatment as of secondary consequence. An improvement,—considered in certain aspects, this special adaptation and alteration of diet is not so in certain others. In point of mere costliness there is no question as to its superiority; nor can there be much doubt as to its superiority in point of suitability to the peculiarities of the individual. But, in respect of

but costliness not synonymous with suitability or Nutritiveness.

the mere quantity or quality of solid nutriment, such a change cannot be regarded as an improvement, few of the substances above mentioned coming within the category of Foods proper at all—and there being no comparison in point of nutritive power *per se* between stimulants and starches on the one hand, and meat, vegetables, and the farinaceous and leguminous flours on the other. We believe that, in public institutions of the hospital class, there is a greater danger or risk of

Dangers of *Over-feeding*.

mischief from *over* than from *under*-feeding—more especially perhaps from an excessive consumpt of nitrogenous nutriment—of animal food—in relation to the requirements of the system, as these are determined by occupation, exercise, and the other modifying causes already so fully considered.

As a Resumé, we may concisely set forth our conclusions—

General propositions as to Diet and Dietaries.

Firstly, as to Public Dietaries in general; and, Secondly, as to those of this Institution in particular—in the following propositions or paragraphs:—

I. In regard to Public Dietaries in general:

1. The cardinal qualities of a Diet, which constitute its nutritiveness or fitness are its
    - *a.* Quantity, especially in relation to the total amount of solid nutriment: and the relative proportions of the nitrogenous, carboniferous, and mineral constituents thereof.
    - *b.* Quality, in reference to digestibility, including the modifications produced by cookery.
    - *c.* Variety, combinations and intermixtures: variations with season, &c.
    - *d.* Accessories, in the form of neurotic beverages, and condiments.
2. The qualities in the Consumer or recipient, modifying the

physiological requirements of his system, and affecting his digestive and assimilative capacity, are his
    - *a.* Occupation, especially in relation to the amount of mechanical labour.
    - *b.* Exercise, especially as regards open-air muscular action.
    - *c.* Condition as to health, both of 1. Body, and
    2. Mind.
    - *d.* Idiosyncrasies—natural or morbid, congenital or acquired.
3. A uniform plan of Tabulation of Public Dietaries is desirable: and this can probably be best accomplished by exhibiting the gross amount of food consumed per person, along with the equivalent in nitrogenous and carboniferous nutriment, calculating the latter according to some fixed standard or scale.
4. For the average adult population of this country, a Diet, which includes a daily allowance per person, of from $3\frac{1}{2}$ to 5 oz. *nitrogenous*; and from 10 to 20 *carboniferous* nutriment, (the latter comprising a due proportion of *salts*), may be considered sufficient as to quantity.
5. Scientifically regarded, no "Regulation" allowance of food, no quantitative rule or Scale, no uniform Dietary, however excellent in itself, can be considered equally suitable for a mixed body of persons differing in occupation, exercise, constitution, and idiosyncrasy.
6. Science and experience alike point to the necessity for a practical recognition, in Dietetic, as well as in medicinal, treatment, of the principle of *Individualisation*.
7. Generally speaking, the Diet of the well-fed of the lower orders is superior, in *nutritive value*, though not necessarily in *fitness*, to that of the higher classes: whose food differs chiefly in its greater variety,—the greater diversity of form given to it by cookery: its superior costliness; and in the *substitution of Dietetic medicines for Foods-proper*.
8. Great improvement is possible and desirable in the present mode of *Cooking* or preparing Foods: whereby both a greater amount of nutriment may be obtained from a given quantity of material, and the same food rendered more savoury and digestible.

II. In regard to the Dietaries of this Institution in particular—

9. A fair average diet for the Insane, under Hospital treatment, embraces a daily allowance per person of 4 oz. *nitrogenous*, and 13 oz. *carboniferous* nutriment, (including *salts*): while one yielding an allowance of 5 oz. of the one, and 20 oz. of the other is to be considered not only as most ample, but as in excess of the physiological requirements, or the digestive capacity, of the majority of patients.
10. The main advantage of Dietaries of such amplitude is the securing *sufficiency, by excess*, of Food.
11. In respect of the quantity of solid nutriment, the Dietaries of this Institution are not only in excess of the physiological requirements of the average of the patients, but they are superior to the majority of Public Dietaries, including those of the Army and Navy.
12. The best typical Dietary, *quoad* the proportion of solid nutriment, simplicity and economy, is that of the *Pauper*.
13. The Dietaries of the higher classes of patients are susceptible of improvement, by approximating them to those of the pauper, *quoad* the character and amount of solid—especially nitrogenous—nutriment: by the substitution of a greater variety of foods of the same class for those presently in use: and by improved modes of Cooking.

APPENDIX

TO

REPORT OF PHYSICIAN;

CONSISTING OF

STATISTICAL AND OTHER TABLES.

I.—GENERAL RESULTS OF THE YEAR 1862-63.

				Males.	Females.	Total.
Patients admitted from 1827 to 1862, ...				669	695	1364
	Males.	Females.	Total.			
Of these Recovered, ..	240	341	581			
,, were Removed improved, ...	89	79	168			
,, ,, ,, unimproved,	104	87	191			
,, Died, ...	151	95	246			
				584	602	1186
Patients remaining on 9th June 1862, ...				85	93	178
,, admitted during the year from June 1862 to June 1863, ...				24	23	47
Total number of Patients under treatment during 1862-3, ...				109	116	225
	Males.	Females.	Total.			
Of these Recovered, ...	7	8	15			
,, were Removed improved, ...	6	3	9			
,, ,, ,, unimproved,	3	3	6			
,, Died, ...	6	9	15			
				22	23	45
Patients remaining on 8th June 1863, ...				87	93	180

Mean daily number of Patients under treatment during 1862-3—177·900

	Males.	Females.	Total.
	24	23	47
1.—Age.			
Between 10 and 15 years,	1	0	1
" 15 " 20 "	2	2	4
" 20 " 30 "	5	4	9
" 30 " 40 "	6	4	10
" 40 " 50 "	5	6	11
" 50 " 60 "	2	5	7
" 60 " 70 "	2	2	4
" 70 " 80 "	1	0	1
2.—Condition as to Marriage.			
Married,	11	6	17
Single,	13	14	27
Widowed,	0	3	3
3.—Form of Insanity.			
Mania: acute,	5	5	10
Chronic,	4	1	5
Erotomania,	0	1	1
Melancholia,	4	9	13
Monomania,	11	7	18
4.—Co-existent Physical Diseases or Defects.			
Amputated arm,	1	0	1
Amenorrhœa,	0	3	3
Cancerous Umbilical tumour,	0	1	1
Debility from abstinence,	1	0	1
" other causes,	2	5	7
Depression of Cranium from old wound,	0	1	1
Dislocation [partial] of Astragalus,	1	0	1
Heart disease,	0	2	2
None,	18	9	27
Suicidal wound of scalp,	1	0	1
" throat,	0	2	2
5.—Duration of Insanity prior to Admission.			
Under 1 week, *	1	1	2
Between 1 week and 1 month, *	8	8	16
" 1 and 6 months, *	10	8	18
" 6 " 12 "	1	0	1
" 1 " 2 years,	1	3	4
" 2 " 5 "	1	2	3
" 5 " 10 "	0	1	1
" 10 " 20 "	2	0	2
6.—Number of previous attacks. †			
One,	2	4	6
Two,	1	1	2
Five,	0	1	1
Several,	1	0	1
7.—Interval since last attack.			
18 months,	1	1	2
2 years,	0	2	2
4 "	2	0	2
7 "	1	1	2
8 "	0	1	1
13 "	0	1	1
8.—Suicidal and Homicidal Propensities. ‡			
Homicidal,	2	1	3
Suicidal,	4	8	12
Homicidal and Suicidal,	1	0	1

* 76.59 per cent. of whole Admissions under 6 months.
† In 21·27 per cent. of whole Admissions.
‡ In 34·04 per cent. of whole Admissions.

	Males.	Females.	Total.
	7	8	15
1.—Age.			
20 years or under,	1	0	1
Between 20 and 30 years,	1	0	1
" 30 " 40 "	0	3	3
" 40 " 50 "	2	1	3
" 50 " 60 "	1	4	5
" 60 " 70 "	1	0	1
" 70 " 80 "	1	0	1
2.—Condition as to Marriage.			
Married,	4	2	6
Single,	3	4	7
Widowed,	0	2	2
3.—Form of Insanity.			
Mania: acute,	2	3	5
" chronic,	0	2	2
Melancholia,	2	2	4
Monomania,	3	1	4
4.—Duration of Insanity prior to Admission.			
One week or under,	1	1	2
Between 1 week and 1 month,	3	2	5
" 1 and 3 months,	1	2	3
" 3 " 12 "	2	3	5
5.—Duration of treatment in Asylum.			
Three months or under,	1	1	2
Between 3 and 6 months,	2	0	2
" 6 " 12 "	2	2	4
" 1 " 2 years,	2	3	5
" 2 " 3 "	0	1	1
" 12 " 13 "	0	1	1

The Recoveries constitute
33·33 per cent. of the Discharges [including Deaths.]
50·00 " " " [excluding "]
31·91 " " Admissions.
8·43 " " Mean daily number of Patients under treatment.
6·66 " " Total number under treatment during the year.

IV.—OBITUARY FOR 1862-3.

No.	Sex.	Age at Death.	Form of Insanity.	Duration of Residence in Asylum.	Duration of Fatal Illness.	Apparent immediate Cause of Death.	RESULTS OF *POST MORTEM* EXAMINATION. Prominent or exceptional Pathological lesions or conditions: Weight of Viscera in ounces Avoirdupois. Head and Spinal Column.	Thorax.	Abdomen.	Other parts of Body.	Additional Remarks.
1.	M.	64	Dementia, chronic	34½ years	2 days	Apoplexy	Weight of Brain 46½ oz.: Clot over middle Lobe of Right Hemisphere: atheroma of Cerebral arteries: adherent Dura mater: Œdema of right side of head and face: Double curvature of spine	Weight of Right Lung, 27½ oz. Weight of Left Lung, 23½ oz. Pneumonic consolidation of both	Weight of Liver, 44½ oz. Weight of Right Kidney 6 oz. Weight of Left Kidney, 5 oz.	..	Had scarcely a day's illness prior to fatal attack
2.	M.	45	Mania, acute	9 days	9 days	Maniacal Exhaustion	No	*Post Mortem*	Examination	..	Dangerously exhausted on admission
3.	F.	66	Melancholia, Suicidal	9 months	..	Suicide by Hanging	Weight of Brain, 47 oz.: Softening of anterior and right middle cerebral lobes: small true aneurism at origin of ophthalmic from internal carotid artery: atheroma of cerebral and meningeal vessels	Weight of Right Lung, 15 oz. Weight of Left Lung, 11½ oz. Hyperæmia of both: general adhesions to thoracic walls	Weight of Liver, 44 oz. Weight of Spleen, 4 oz. Weight of Right Kidney 3½ oz. Weight of Left Kidney, 4½ oz.	..	Hemiplegia affecting left side on admission
4.	F.	45	Suspicious Monomania: Dementia	1½ year	1½ year	Phthisis pulmonalis	Weight of Brain, 42 oz.	Weight of Heart, 6½ oz. Weight of Right Lung, 22½ oz. Weight of Left Lung, 17 oz. Tubercular infiltration of both: Vomicæ in left	Tubercular ulceration of Ileum and Jejunum	..	Extreme emaciation and debility on admission
5.	F.	60	Dementia, chronic	31 years 8 months	1 week	Senile exhaustion	Adhesion of Meninges to Calvarium	Hyperæmia of base of both Lungs	..	..	..
6.	F.	65	Mania, acute	6 weeks	19 hours	Apoplexy	Weight of Brain, 51½ oz.: numerous osseous scales in Falx and Dura mater: rent of left posterior cerebral lobe, leading to a softened portion containing a clot: cretaceous bodies in choroid plexus: atheroma of cerebral vessels	Pneumonic hepatization of base of Right Lung	Weight of Liver, 56 oz. Weight of Right Kidney 7½ oz. Weight of Left Kidney, 6½ oz. Hepatic abscesses: fatty kidneys: cancerous Umbilical tumour associated with cancerous omental tumours.	..	Attempted strangulation of the Umbilical tumour by worsted threads. Resultant ulceration would have opened into Peritoneum and been fatal by Peritonitis

IV.—OBITUARY FOR 1862-3—[CONTINUED].

No.	Sex.	Age at Death.	Form of Insanity.	Duration of Residence in Asylum.	Duration of Fatal Illness.	Apparent immediate Cause of Death.	RESULTS OF *POST MORTEM* EXAMINATION. Prominent or exceptional Pathological lesions or conditions: Weight of Viscera in ounces Avoirdupois. Head and Spinal Column.	Thorax.	Abdomen.	Other parts of Body.	Additional Remarks.
7.	M.	39	General Paralysis	4 years 1 month	3 weeks	Convulsions and Coma	Weight of Brain, 47½ oz.: osseous plate in Falx pressing on left hemisphere: false membrane entirely covering left, and partially covering right, cerebral hemispheres: increase of serum: suppuration of right internal ear: lymphy exudation along spinal cord	Weight of Right Lung, 21½ oz. Weight of Left Lung, 14½ oz. Hyperæmia of right	Renal Hyperæmia: lymphy, granular roughening of mucous membrane of Bladder—with hæmorrhagic patches	Hæmorrhagic infiltration of temporal and aural muscles of left side, and *Psoas magnus* of right side	Long subject to incomplete Hemiplegia, generally of right side: associated with persistent dilatation of right Pupil
8.	F.	73	Mania, chronic Dementia	8 months	5 weeks	Broncho-pneumonia	Weight of Brain, 46½ oz.: thickening of arachnoid over anterior cerebral lobes: softening of walls of 3d ventricle	Weight of Right Lung, 32 oz. Weight of Left Lung, 8 oz. Broncho-pneumonia of right [base]: interlobular emphysema of left	Weight of Liver, 29½ oz. Weight of Right Kidney 4 oz. Weight of Left Kidney, 4 oz. Congenital displacement of abdominal viscera—stomach and ascending colon reaching to third rib on left side. Hæmorrhagic infiltration of left Supra renal capsule	..	..
9.	M.	54	Melancholia, Suicidal	7 months	5 days	Apoplexy	Weight of Brain, 52 oz.: Adhesions of Dura mater: subarachnoid effusion: cyst over superior vermiform process of cerebellum: subluxation of odontoid process of axis: softening of cervical portion of spinal cord: spinal effusion	Weight of Right Lung, 19 oz. Weight of Left Lung, 28 oz. Pneumonic Hepatization of left	Weight of Spleen, 7½ oz. Hepatic and gastric Hyperæmia	Cicatrix of suicidal wound over frontal bone	Stiffness of neck and tremor of hands prior to death

IV.—OBITUARY FOR 1862-3—[CONTINUED].

No.	Sex.	Age at Death.	Form of Insanity.	Duration of Residence in Asylum.	Duration of Fatal Illness.	Apparent immediate Cause of Death.	RESULTS OF *POST MORTEM* EXAMINATION. Prominent or exceptional Pathological lesions or conditions: Weight of Viscera in ounces Avoirdupois. Head and Spinal Column.	Thorax.	Abdomen.	Other parts of Body.	Additional Remarks.
10.	F.	73	Mania, chronic: acute paroxysms	26 years	1 week	Exhaustion of senility and mania	Weight of Brain, 41¾ oz: adherent Dura mater: small fibroid tumour pendent from Falx: spinal curvature	Weight of Heart, 18½ oz. Heart fatty and enlarged: interlobular emphysema in anterior portion of right lung: apicial pneumonic consolidation of left	Weight of Liver, 33½ oz. Hyperæmia of upper part of Duodenum: interstitial deposit in lower part of Ileum [Peritoneal coat]: modified or partial Umbilical Hernia: large cystic tumour of left ovary	General osseous degeneration [softening]: general vascular atheroma	..
11.	F.	49	Melancholia, Suicidal	6 days	6 days	Pleurisy and Empyema	Weight of Brain, 48¾ oz.: firm adhesions of Dura mater to calvarium: softening of right crus cerebri in front of Pons: partial disorganization of right optic thalamus: lymphy exudation at upper part of spinal cord	Weight of Heart, 15 oz. Compression of left Lung: occupation of left pleural cavity by bloody-purulent fluid: abscess of lower cervical vertebræ: enlargement of right cardiac Auricle: pericardial effusion	Weight of Liver, 66½ oz. Weight of Spleen, 10½ oz. Hepatic enlargement—nutmeg character: induration of left supra-renal capsule: cysts of both ovaries	Suicidal wound of throat	Moribund on admission
12.	M.	36	Melancholia	10 days	10 days	Gastro-enteritis	Weight of Brain, 52 oz.: general cerebral œdema: serous distension of lateral ventricles	Weight of Right Lung, 19½ oz. Weight of Left Lung, 16 oz.	Weight of Liver 30 oz. Weight of Spleen, 7½ oz. Weight of Right Kidney 7½ oz. Weight of Left Kidney, 6¾ oz. Intense Hyperæmia of stomach and intestines: peritoneal effusion and lymphy exudation: renal Hyperæmia	..	Moribund on admission
13.	F.	62	Mania, acute	2½ months	2½ months	Strangulated Femoral Hernia	Weight of Brain, 47 oz.: general cerebral softening: serous distension of lateral ventricles	Weight of Heart, 8½ oz. Weight of Right Lung, 16½ oz. Weight of Left Lung, 9¾ oz. Consolidation [pneumonic] of middle lobe of right lung	Weight of Right Kidney 5 oz. Weight of Left Kidney, 4 oz. General Hyperæmia and discoloration of Intestines: intense inflammatory Hyperæmia of Ileum—a knuckle of which was strangulated as a Hernia in the crural canal: recent adhesions of intestines to abdominal parietes	..	..

IV.—OBITUARY FOR 1862-3—[CONTINUED].

No.	Sex.	Age at Death.	Form of Insanity.	Duration of Residence in Asylum.	Duration of Fatal Illness.	Apparent immediate Cause of Death.	RESULTS OF *POST MORTEM* EXAMINATION. Prominent or exceptional Pathological lesions or conditions: Weight of Viscera in ounces Avoirdupois. Head and Spinal Column.	Thorax.	Abdomen.	Other parts of Body.	Additional Remarks.
14.	M.	46	Imbecility, congenital	2½ years	2½ weeks	Phthisis pulmonalis	Weight of Brain, 57 oz.: softening and disorganization [marked by presence of Amyloid bodies, &c.] of anterior cerebral lobes over cribriform plate of Ethmoid	Weight of Right Lung, 46 oz. Weight of Left Lung, 36 oz. Both infiltrated with Tubercles—mostly miliary in left: vomicæ in front of right and general adhesions to thoracic parietes	Weight of Liver, 47½ oz. Weight of Spleen, 4¾ oz. Weight of Right Kidney 6 oz. Weight of Left Kidney, 5¼ oz.	Œdema of left arm and plugging by clot of all its veins: slight plugging of right femoral vein	..
15.	F.	33	Melancholia, Suicidal	6½ days	6½ days	Valvular disease of heart: Pneumonia	Weight of Brain, 53½ oz.: Irregularity of cranial interior by angular projections and correspondingly deep fossæ, &c.	Weight of Heart, 15¼ oz. Weight of Right Lung, 27½ oz. Weight of Left Lung, 28¾ oz. Dilatation, with hypertrophy, of right side of heart: dilatation of right auriculo-ventricular opening: thickening, by deposit, of tricuspid valve: muscular texture of heart fatty. Left Lung and inferior lobe of right in state of pneumonic hepatization: displacement backwards of left Lung by enlarged and abnormally placed heart	Weight of Liver, 57½ oz. Weight of Spleen, 3½ oz. Weight of Right Kidney 3½ oz. Weight of Left Kidney, 4½ oz. Fibrinous deposit in Spleen: Hyperæmia of left Kidney: inflammation of right Fallopian Tube	..	Heart disease was apparently at least of 4 years' growth or duration

The Deaths constitute 33·33 per cent. of the Discharges [including Deaths].
" " 31·91 " Admissions.
" " 8·43 " Mean daily number of Patients under treatment.
" " 6·66 " Total number under treatment during the year.

V.—SHEWING THE MINOR OR NON-FATAL AFFECTIONS OR DISEASES PREVALENT DURING 1862-3.

	1862. Number or frequency of such affections* or diseases during the Months of — June 9th to 30th	July	August	September	October	November	December	1863. January	February	March	April	May	June to 8th	TOTAL
Abscess, ...	2	1	2	0	0	4	1	2	2	1	1	1	0	17
Apoplexy, ...	0	0	0	0	0	0	0	0	0	0	1	0	0	1
,, congestive, ...	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Bronchitis, ...	0	0	0	0	1	1	0	0	1	1	1	1	0	6
Caries of Carpus and Metacarpus,	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Catarrh, ...	1	0	0	0	1	1	3	2	4	1	2	1	0	16
Clavicle, fracture of, ...	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Conjunctivitis, ...	0	0	0	0	0	0	0	0	0	1	1	0	0	2
Cranium, fracture of, ...	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Cynanche parotidea, ...	0	0	0	0	0	0	0	0	1	0	0	0	0	1
,, tonsillaris, ...	0	0	0	0	1	0	0	0	1	0	0	0	0	2
Diarrhoea, ...	2	1	9	3	3	1	1	0	1	2	1	1	0	25
Dyspepsia, ...	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Erysipelas, ...	0	0	0	0	1	1	0	0	0	0	0	0	1	3
Erythema, ...	0	0	0	0	1	0	0	0	1	0	0	0	0	2
Eczema, ...	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Furunculi, ...	0	3	0	0	2	3	2	1	1	1	1	1	1	16
Hemorrhoids [external], ...	0	0	0	0	0	0	0	0	1	0	0	0	0	1
,, [internal], ...	0	0	0	1	0	0	0	0	1	0	0	0	0	2
Hemiplegia, partial, ...	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Hernia [double inguinal reducible]	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Herpes labialis, ...	0	1	0	0	1	0	0	0	0	0	0	0	0	2
Menorrhagia, ...	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Otitis [external], ...	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Paronychia, ...	0	1	0	0	2	0	1	0	0	0	0	0	3	7
Parulis, ...	1	0	1	0	0	0	0	0	0	0	1	1	0	4
Phlebitis, ...	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Poisoning by Laburnum Bark,	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Psoriasis, ...	0	1	0	0	0	0	0	1	0	0	0	1	0	3
Rheumatism, ...	1	0	0	0	0	0	0	0	1	0	0	1	0	3
Ribs, fracture of, ...	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Synovitis, ...	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Tumour of Shoulder, ...	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Ulcer, simple, ...	0	1	0	1	0	0	0	0	0	1	1	0	0	4
,, weak, ...	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Urticaria, ...	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Varix, ...	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Wound [Scalp] of Head, ...	0	0	0	0	0	0	0	2	0	0	0	0	0	2

* This does not necessarily indicate the number of *Patients* affected: inasmuch as the *same* Patient may be, and occasionally has been, the subject, at different times, or even at the same time, of *different* affections.

VI.—INDUSTRIAL OPERATIONS.

1.—SHEWING THE AVERAGE MAXIMUM NUMBER OF PATIENTS EMPLOYED DURING 1862-3.

DEPARTMENTS OF LABOUR.	Males.	Females.	Total.
1.—*Gardener's Department.*	30	...	30
a. Garden work proper—			
Digging and trenching; pruning and hedging; planting and dressing; grass cutting; greenhouse and potting-house work, &c., ...	15	..	15
b. Farm work—			
Pigs and piggeries, ...			
Cows and byres, ...	1	...	1
Straw carrying, &c., ...	1	...	1
c. Pump work, ...	6	...	6
d. Assisting masons in building operations—	10	...	10
Taking down walls; wheeling rubbish; digging foundations; laying out terraces, &c., ...	15	...	15
e. Miscellaneous—			
Cutting down timber; splitting firewood, &c., ...	6	...	6
2.—*Artisan Department.*	10	...	10
a. Carpenter work, ...	2	...	2
b. Tailoring, ...	2	...	2
c. Shoemaking, ...	3	..	3
d. Painting and whitewashing, ...	3	...	3
e. Basket making, ...	1	...	1
f. Mat and mattress making, ...	1	...	1
3.—*Milliner's Department.*	30	...	30
a. Plain work—			
Stocking making and mending; dress, shirt, and cap making; quilt, braces, and slipper making, &c., ...	...	25	...
b. Fancy work—			
Embroidery; crotchet, &c., ...	...	5	30
4.—*Laundry Department.*			
Washing; ironing; mangling; furnace attendance, &c.,	...	15	15
5.—*Kitchen Department.*			
Under cooks, ...	...	2	2
6.—*House Department.*			
Assistants to housemaids, ...	...	2	2
7.—*Gallery Department.*			
Cleaning rooms and galleries; cleaning table furnishings, cutlery, &c.; bed making; coal carrying; fire tending; window cleaning, &c., ...	15	10	25
8.—*Miscellaneous Department.*			
Furnace assistance, ...	1	...	1
Coir picking and hair teasing; pillow and mattress stuffing, &c., ...	5	5	10

The foregoing indicate the principal kinds or departments of industrial operations engaged in. But, though, in certain cases, there is a special separation or division of labour, different individual or classes of Patients working only in special departments; more commonly the same patient, at different times, and under different conditions of his own mental and physical health, engages in two or more of the operations classified under the different departments aforesaid.

Average total number of Patients employed in all departments of industrial labour,—Males, 40; Females, 60—total, 100: or in other words about 50 per cent. of the males, 65 per cent. of the females, and 57½ per cent. of both sexes—calculating on the average numbers resident.

2.—SHEWING THE VALUE OF WORK DONE DURING 1862.

DEPARTMENTS OF LABOUR.	Value of Articles Made. £	s.	D.	Value of Material Used. £	s.	D.	Nett Value of Labour. £	s.	D.
1.—*Gardener's Department.*									
a. Garden, ...							102	7	6
b. Pumps, ...							88	15	0
c. Farm yard, ...							20	8	6
							211	11	0
2.—*Milliner's Department.*									
a. Millinery, &c., ...	491	15	4	385	4	2	106	11	2
3.—*Artizan Department.*									
a. Shoemaker, ...	85	3	7	47	11	9	37	11	10
b. Tailor, ...	66	18	1	43	5	6	23	12	7
c. Carpenter, ...	23	2	9	10	11	10	12	10	11
d. Blacksmith and Plumber,	3	12	9	—	13	3	2	19	6
e. Glazier, ...	9	14	6	4	2	—	5	12	6
f. Mason, ...	—	—	—	—	—	—	—	15	6
4.—*Miscellaneous Department.*									
a. Painter, &c., ...	113	7	10	14	10	3	98	17	7
Total, ...	793	14	10	505	18	9	500	2	7

TABLES RELATING TO DIETARIES.

I.—WEEKLY SCALE OF DIET FOR A MALE WORKING PAUPER.

	No. of Days ℔ Week	Weight in oz. Avoirdupois: Allowance ℔ Day	Regular Weekly Allowance	Additional & occasional Allowance
1.—Butcher Meat* † (1)—				
a. To Dinner. Roast or boiled, ...	3	8	24	...
b. To Dinner. In Soup or Broth (occasionally also on Wednesdays in Winter), ...	4	4½	18	...
c. To Dinner. In Meat and Potato Pie (baked), ...	1	7	7	...
d. To Dinner. In lieu of Fruit Pie on Wednesdays in Winter (mostly baked), ...	1	...	...	4
e. To Dinner. In lieu of Fish; occasionally on Fridays (mostly baked), ...	1	...	...	4
			57	...
* Deduction (2) for bone, fat, and refuse, about 35 per cent., or	...	...	20	...
Nett, ...	...	...	37	...
† Includes fresh Beef, Mutton, and Pork, of best quality.				
2.—Fish—(3)—white (including Haddock, Cod, Flounder, Herring), and Salt Fish (Cod and Ling)—to dinner,	1	8	8	...

1. About one-fifth of the Butcher Meat consumed in the Institution is pickled or salted; the pickling materials being generally *Salt or Nitre*, and occasionally, in addition, Sugar and Spices (the latter especially in the case of Tongues).

2. The deduction in this and all other Dietary Tables of this Institution for Bone, Suet and refuse is exclusive of *loss by cooking*, which necessarily varies greatly, and cannot therefore be so precisely estimated.

3. About one-eighth of the Fish consumed in the Institution is salted or cured.

I.—WEEKLY SCALE OF DIET FOR A MALE WORKING PAUPER.

	No. of Days ℔ Week	Weight in oz. Avoirdupois: Allowance ℔ Day	Regular Weekly Allowance	Additional & occasional Allowance
3.—Bread—white—best quality wheat (occasionally brown or currant Bread, &c.)—				
a. To Breakfast, ...	7	4	28	...
b. ,, Lunch, ...	6	4	24	...
c. ,, Dinner, ...	7	4½	32	...
d. ,, Occasionally on Wednesdays in Winter,	1	...	...	2
e. ,, Supper, ...	3	8	24	...
			110	...
4.—Oatmeal—best Scotch—				
a. In Porridge, to Breakfast, ...	7	4	28	...
b. ,, ,, Supper, ...	4	4	16	...
c. In Meal Pudding on Sundays occasionally—to dinner, ...	1	...	...	6½
			50½	...
5.—Wheaten Flour—best American—				
a. In Fruit and Meat Pie (crust or pastry), ... To Dinner.	2	2	4	...
b. ,, Currant Pudding or Dumpling, occasionally, ... To Dinner.	1	...	...	5
			9	...
6.—Barley—Pearl—best Scotch—				
a. In Broth—To dinner (occasionally also on Wednesdays in Winter), ...	3	1¼	3¾	...
7.—Potatoes*—best Scotch—				
a. To Dinner. With Meat, ...	4	14	56	...
b. To Dinner. In Meat and Potato Pie, ...	1	12	12	...
c. To Dinner. Occasionally on Wednesdays in Winter, ...	1	...	..	8
			76	...
* Other Vegetables (as immediately undermentioned) occasionally substituted when Potatoes are bad or scarce.				
8.—Miscellaneous Vegetables—(including Carrot, Turnip, Cabbage, Cauliflower, Greens (Kail), Brussels Sprouts, Leeks and Onions, Parsley, Beans, Green Peas)—				
a. To Dinner. In Broth or Soup (mixed Vegetables)—occasionally, also, on Wednesdays in Winter, ...	4	4½	18	...
b. To Dinner. With Meat, (Greens, &c.), ...	3	2⅔	8	...
c. To Dinner. In Oatmeal Pudding (Onions only)—on Sundays, occasionally, ...	1	¾	...	¾
d. To Dinner. In Meat Pie—Beef, Mutton, or Pork—(Onions only), ...	1	½	½	...
			27¼	...
9.—Fruit, miscellaneous—(including Rhubarb, Apples, Pears, Currants, Gooseberries, Strawberries, Raspberries, Blackberries),				
a. To Dinner. In Fruit Pie,... ... in Spring and Summer,	1	16	16	...
b. To Dinner. As Dessert—occasionally, when plentiful, ... in Spring and Summer,	3	5	...	15
c. To Dinner. In Dumplings—as Jam or Jelly—in Winter.	1	...	...	1
			32	...

I.—WEEKLY SCALE OF DIET FOR A MALE WORKING PAUPER.

	No. of Days ⅌ Week	Weight in oz. Avoirdupois		
		Allowance ⅌ Day	Regular Weekly Allowance	Additional & occasional Allowance
10.—Peas—dry—split—best Scotch— a. To Dinner—in Pea Soup, ...	1	2½	2½	...
11.—Rice—best Patna—(whole Rice only)— a. To Dinner—in Rice Pudding, ...	1	1½	1½	...
12.—Sugar—best Brown— a. To Dinner.—In Rice Pudding, ...	1	½	½	...
b. To Dinner.—In Fruit Pie—in Summer, occasionally, ...	1	2	...	2
c. ,, Supper—in Tea, Coffee, or Cocoa, ...	3	¾	2¼	...
d. ,, Breakfast—in Coffee, ...	7	½	3½	...
			8¼	...
13.—Butter—best Salt—Scotch— a. To Breakfast, with Bread—generally in addition to Porridge,	7	$\frac{1}{7}$	1	...
b. ,, Supper, with Bread—generally in addition to Porridge, ...	3	½	1½	...
			2½	...
14.—Suet, Fat or Lard— a. To Dinner.—In Broth or Soup—(Dripping, Marrow, &c.)—occasionally, also, on Wednesdays, in Winter, ...	4	½	2	...
b. To Dinner.—,, Fruit Pie—(Lard or Dripping), ... Pastry.	2	½	1	...
c. To Dinner.—,, Meat Pie—(Lard), Pastry.	1	½	½	...
d. To Dinner.—,, Meal Pudding, Currant Dumpling or Pies (Suet)—on Sundays occasionally, ...	1	2½	...	2½
			6	...
15.—Milk—best sweet—sp. gr. 1030-5— a. To Breakfast, with Porridge, ...	7	10	70	...
b. ,, Supper, ,, ...	4	10	40	...
c. ,, ,, with Tea, Coffee or Cocoa, ...	3	3⅓	10	...
d. ,, Dinner—in Rice Pudding—occasionally, ...	1	13	...	13
			133	...
16.—Cheese—best Gouda— a. To Lunch at 11 A.M.—with Bread, ...	6	1	6	...
17.—Beer—best Scotch— a. To Lunch, ...	6	10	60	...
b. ,, Dinner (in lieu of Soup), ...	4	10	40	.
			100	...
An equal amount of *Porter* substituted in special cases.		Drms.	Drms.	
18.—Tea, Coffee or Cocoa, a. To Breakfast—Coffee, ...	7	2$\frac{2}{7}$	16	...
b. ,, Supper— ,, ...	1	5¼	5¼	...
b. ,, Supper—Tea, ...	1	2¼	2¼	...
b. ,, Supper—Cocoa, ...	1	7¼	7¼	...
			2 oz	

The *Meal hours* for all classes of Patients are—Breakfast, 8 A.M. Dinner, 1 P.M. Tea, 6 ,,

There is no separate Lunch nor Supper save in special cases.

☞ The quantities given in this and the other Dietary Tables of this Institution are those of raw or uncooked food.

II.—WEEKLY SCALE OF DIET FOR A MALE PATIENT OF THE INTERMEDIATE CLASS.

	No. of Days ⅌ Week	Weight in oz. Avoirdupois		
		Allowance ⅌ Day	Regular Weekly Allowance	Additional & occasional Allowance
1.—Butcher Meat * †— a. To Dinner.—Roast, baked, boiled, or stewed—(including Meat Pie (1) and Irish Stew (2) occasionally), ...	5	10	50	...
b. To Dinner.—In Soup or Broth, (3) ...	7	1	7	...
c. To Dinner.—In lieu of Fish, ...	1	10	...	10
			67	...
* Deduction for bone, fat, and refuse, about 35 per cent., or	...	...	23	...
Nett, ...	...	...	44	...
† Includes fresh Beef, Mutton, Pork, Lamb, and Veal; as well as Bacon—all of best quality.				
2.—Rabbits (after deduction of about 20 per cent. for bone, &c.) To Dinner—in Pie or stewed, ...	1	10	10	...
3.—Fish—white (including Haddock, Cod, Whiting, Flounder, Herring)— To Dinner.	1	10	10	...
a. In lieu of Meat—occasionally when fish are plentiful, ... To Dinner.	1	10	...	10
			20	...
4.—Bread—white—best quality wheat (including Scones, Rolls, Biscuits, &c.)— a. To Breakfast—with Tea or Coffee, ...	7	9	63	...
b. ,, Tea, do., ...	7	9	63	...
c. ,, Dinner, ...	7	2	14	...
d. ,, ,, in lieu of Potatoes—occasionally—when Potatoes are bad or scarce, ...	1	...	..	3
			143	...
5.—Oatmeal—best Scotch— To Breakfast or Tea—as Cakes, ...	1	2½	2½	...
6.—Wheaten Flour—best American— a. To Dinner.—In Fruit and Meat Pie (crust or pastry), ...	2	1½	3	...
b. To Dinner.—In Currant, Rhubarb, or Apple Dumplings, or Puddings, ...	1	2	2	...
			5	...
7.—Barley—Pearl—best Scotch— To Dinner—in Broth, ...	5	1	5	...
8.—Potatoes *—best Scotch— To Dinner, ...	7	14	98	...
* Other Vegetables (as immediately undermentioned) occasionally substituted when Potatoes are bad or scarce.				
9.—Miscellaneous Vegetables—(including Carrot, Turnip, Cabbage, Greens, Brussels Sprouts, Cauliflower, Peas, Beans, Onions and Leeks, Parsley, &c.)— a. To Dinner.—In Broth or Soup, ...	7	2	14	...
b. To Dinner.—With Meat—as Salad, &c., ...	4	4	16	...
c. To Dinner.—Do., occasionally in Summer when abundant, ...	2	4	...	8
			38	...

1. *Meat Pie* consists of 5 oz. Meat, 2 oz. Flour, 1 oz. Lard, per person.
2. *Irish Stew* consists of 5 oz. Meat and 5 oz. Potatoes, Onions, &c., per person.
3. *Liquor of Cooked Meat* is the basis of most Broths and Soups.

II.—WEEKLY SCALE OF DIET FOR A MALE PATIENT OF THE INTERMEDIATE CLASS.

	No. of Days ⅌ Week	Weight in oz. Avoirdupois		
		Allowance ⅌ Day	Regular Weekly Allowance	Additional & occasional Allowance
10.—Fruit, miscellaneous (4)—(including Rhubarb, Apples, Pears, Gooseberries, Strawberries, Raspberries, Blackberries, Plums, Currants, (5) Raisins, Cherries, &c.)—				
a. To Dinner. In Pie, (6) Tart, or Dumpling, ...	1	6	6	...
b. To Dinner. Do., in lieu of Rice or other Pudding, occasionally, ...	1	6	...	6
c. To Dinner. As Dessert—in Summer, ...	4	6	...	24
d. „ Tea—as Jam or Jelly—in Winter, ...	1	1	1	...
			37	...
11.—Peas—dry—split—best Scotch—				
a. To Dinner. In Pea Soup, ...	1	2	2	...
b. To Dinner. In lieu of Barley in Broth—occasionally, ...	1	2	...	2
			4	...
12.—Rice—best Patna—(including Ground Rice, Sago, &c.)—				
a. To Dinner. In Soup, ...	1	1	1	...
b. To Dinner. In Rice or other Pudding (7)—(or as "Rice and Milk" (8) occasionally),	1	1½	1½	...
			2½	...
13.—Sugar—best Brown—				
a. To Breakfast, with Coffee, ...	7	1⅛	8	...
b. „ Tea, „ Tea, ...	7	1	7	...
c. „ Dinner. In Fruit Pie or Puddings, ...	2	1¼	2½	...
d. „ Dinner. Do. occasionally in Summer,	1	2	...	2
			19½	...
14.—Butter—Salt and Fresh—best Scotch—				
a. To Breakfast, ...	7	½	3½	...
b. „ Tea, ...	7	½	3½	...
c. „ Dinner—in Pie crust, and Sauce, ...	3	½	1½	...
			8½	...
15.—Suet, Fat, Lard, &c.—				
a. To Dinner. In Broth or Soup—(Dripping, Marrow, &c.), ...	7	½	3½	...
b. To Dinner. In Dumplings or Puddings—(Suet),	1	1½	1½	...
c. To Dinner. In Fruit and Meat Pie crust—(Lard),	2	1	2	...
			7	...
16.—Milk—best sweet—sp. gr. 1030-5—				
a. To Breakfast, with Coffee, ...	7	3	21	...
b. „ Tea, „ Tea, ...	7	2	14	...
c. „ Dinner, „ Rice or other Pudding,	1	10	10	...
d. „ Dinner, Do. in lieu of Tart—occasionally, ...	1	10	...	10
			55	...

4. *Fruit Dumpling* consists of 5 oz. Apples, Gooseberries, &c., 2½ oz. Flour, 1½ oz. Sugar, 1 oz. Lard, per person.
5. *Currant Dumpling* consists of 4 oz. Flour, 3 oz. Suet, 2 oz. Currants, 1 oz. Sugar, per person.
6. *Fruit Pie* consists of 4 oz. Fruit, 1½ oz. Flour, 1½ oz. Sugar, 1 oz. Lard, per person.
7. *Rice Pudding* consists of 1½ oz. Rice, 1½ oz. Sugar, and 8 oz. milk, per person.
8. *Rice and Milk* consists of 3 oz. Rice, 1 oz. Sugar, 12 oz. Milk, per person.

II.—WEEKLY SCALE OF DIET FOR A MALE PATIENT OF THE INTERMEDIATE CLASS.

	No. of Days ⅌ Week	Weight in oz. Avoirdupois		
		Allowance ⅌ Day.	Regular Weekly Allowance.	Additional & occasional Allowance.
17.—Cheese—best Gouda— To Dinner—on Sundays, ...	1	1	1	...
18.—Beer—best Scotch— To Dinner, ...	7	15	105	...
		Drms.	Oz. Dr.	
19.—Tea,* or Coffee,*				
a. To Breakfast—Coffee, ...	7	7	3 1	
b. „ Tea—Tea, ...	7	3½	1 8½	
			4 9½	

* 12 drachms Cocoa may be substituted at morning and evening meals, or both; and Tea or Coffee may be substituted for the other at either meal.

III.—WEEKLY SCALE OF DIET FOR A MALE PATIENT OF THE HIGHER CLASS.

	No. of Days ⅌ Week	Weight in oz. Avoirdupois		
		Allowance ⅌ Day	Regular Weekly Allowance	Additional & occasional Allowance
1.—Butcher Meat * †—				
a. b. To Dinner. Roast, boiled, baked, or stewed (Irish stew, (1) &c.), ...	4	10	40	...
c. To Dinner. Do. occasionally,	1	4	...	4
d. To Dinner. In Meat Pie, (2)	1	8	8	...
e. To Dinner. In Soup or Broth, ...	7	2	14	...
To Breakfast (generally *cold* Meat, Ham, Tongue; or Ham and Eggs, &c.), ...	2	3	6	...
			72	...
* Deduction for bone, fat, and refuse, about 35 per cent., or	...	...	25	...
Nett, ...	...	...	47	...
† Includes fresh Beef, Mutton, Pork, Lamb, Veal; as well as Ham and Bacon, all of best quality.				
2.—Poultry and Game—(including Fowls, Ducks, Pigeons, Rabbits, &c.)—after deduction of about 20 per cent. for bone, &c.)—				
a. To Dinner. In lieu of Butcher Meat, ...	1	10	10	...
b. To Dinner. Do. occasionally,	1	5	...	5
			15	...
3.—Fish—(including Haddock, Cod, Flounder, Whiting, Sole, Ling, Herring, Salmon, Trout; and Shell Fish—Crab, &c.)—				
a. To Dinner. In lieu of Butcher Meat, ...	1	8	8	...
b. To Dinner. Do. occasionally,	1	4	...	4
c. „ Breakfast, Do.	3	6	18	...
			30	...

1. *Irish Stew* consists of 6 oz. Meat, 6 oz. Potatoes and Onions, &c., per person.
2. *Meat Pie* „ 5 oz. „ 13 oz. Flour, 2 oz. Lard, „

II.—WEEKLY SCALE OF DIET FOR A MALE PATIENT OF THE HIGHER CLASS.

	No. of Days ℘ Week.	Weight in oz. Avoirdupois. Allowance Day.	Regular Weekly Allowance.	Additional & occasional Allowance.
4.—Bread—white—best wheaten—(including Scones, Rolls, Biscuits, Cakes, &c.)—				
a. To Breakfast, ...	7	8	56	...
b. ,, Tea,...	7	8	56	...
c. ,, Dinner. { With Meat, ...	7	2	14	...
d. ,, Dinner. { In lieu of Potatoes —occasionally,	1	4	...	4
			130	...
5.—Oatmeal—best Scotch—				
As Cakes or Pudding—to Dinner, Breakfast, or Tea, ...	1	2	2	...
Do. occasionally,	1	2	...	2
			4	...
6.—Wheaten Flour—best American—				
a. To Dinner. { In Meat or Fruit Pie, or Tart crusts,	4	1½	6	...
b. To Dinner. { ,, Suet or Fruit Dumpling—occasionally, ...	1	2	...	2
c. ,, Tea, ,, Sweet Cake (Tea bread) do.,	1	3	...	3
			11	...
7.—Barley—Pearl—best Scotch—				
To Dinner—in Broth, ...	3	1	3	...
8.—Potatoes—best Scotch—				
To Dinner, ...	7	14	98	...
9.—Miscellaneous Vegetables—(including those used in the Pauper and Intermediate Dietaries:—and in addition Beet Root, Lettuce, Radish, Seakale, Asparagus, Celery, &c.)—				
a. To Dinner. { In Soup, ...	7	2	14	...
b. To Dinner. { With Meat—as Salad, &c., ...	7	4	28	...
			42	...
10.—Fruit, (1) miscellaneous—(including that used in the Pauper and Intermediate Dietaries:—and in addition, especially in Winter,—as Dessert,—Oranges, Figs, Prunes, Raisins, Almonds, &c.)—				
a. To Dinner. { In Tarts, (2) Dumplings, (3) or Puddings	3	4	12	...
b. To Dinner. { As Dessert, ...	4	3	12	...
c. ,, Tea—as Jams or Jellies—occasionally,	3	2	...	6
			30	...
11.—Peas—dry—split—best Scotch—				
a. To Dinner. { In Pea Soup, ...	1	2	2	...
b. To Dinner. { ,, lieu of Barley in Broth—occasionally, ...	1	2	...	2
c. To Dinner. { ,, Pease Pudding, do.,	1	1	...	1
			5	...
12.—Rice—best Patna—(including Ground Rice, Sago, Tapioca, Indian Corn, Oswego Corn, Maizena, &c.)—				
a. To Dinner. { In Soup, ...	1	1	1	...
b. To Dinner. { ,, Rice or other Puddings, ...	3	1½	4½	...
			5½	...

1. *Fruit Pie* consists of 5 oz. Fruit, 2 oz. Flour, 1½ oz. Lard, 1½ oz. Sugar, per person.
2. *Tart* ,, 1 oz. Jam, 2 oz. ,, 1 oz. ,, ,,
3. *Fruit Dumpling* ,, 4 oz. Fruit, 3 oz. ,, 1½ oz. ,, 1½ oz. ,, ,,

III.—WEEKLY SCALE OF DIET FOR A MALE PATIENT OF THE HIGHER CLASS.

	No. of Days ℘ Week	Weight in oz. Avoirdupois Allowance ℘ Day	Regular Weekly Allowance	Additional & occasional Allowance.
13.—Sugar—(including best Brown, Crushed, White Loaf, &c.)—				
a. To Breakfast, ...	7	1¼	8	...
b. ,, Tea, ...	7	1	7	...
c. ,, Dinner. { In Fruit Pie, Tarts, &c., ...	3	2	6	...
d. ,, Dinner. { ,, Rice, Suet, or other Puddings,	4	½	2	...
			23	...
14.—Butter—Fresh and Salt—best Scotch—				
a. To Breakfast, ...	7	½	3½	...
b. ,, Tea, ...	7	½	3½	...
c. ,, Dinner—in Pastry, Cakes, Fish and other Sauces, &c., ...	5	⅖	2	...
15.—Suet, Fat, Lard, &c.—			9	...
a. To Dinner. { In Soup—(Dripping, Marrow, &c.),	7	½	3½	...
b. To Dinner. { ,, Suet Puddings, ...	1	2	2	...
c. To Dinner. { ,, Pastry, Tarts, &c., ...	4	1	4	...
			9½	...
16.—Milk—best sweet—sp. gr. 1030-5: and Cream—				
a. To Breakfast, ...	7	3	21	...
b. ,, Tea, ...	7	3	21	...
c. ,, Dinner—with Puddings or Fruit, ...	5	6	30	...
			72	...
17.—Cheese—best Gouda, Gloucester, Cheshire, &c.—				
a. To Dinner. { As Dessert, ...	1	1	1	...
b. To Dinner. { Do. occasionally,	6	1	...	6
			7	...
18.—Eggs—				
a. To Breakfast, ...	3	2	6	...
b. ,, Tea—in Cake, &c.—occasionally, ...	1	2	...	2
c. ,, Dinner—in Puddings, ...	3	2	6	...
			14	...
19.—Beer—best Scotch—				
To Dinner, ...	7	15 Drms.	105 Oz.	...
20.—Tea or Coffee *—				
a. To Breakfast—Coffee, ...	7	8	3½	...
b. ,, Tea—Tea, ...	7	4	1¾	...
			5¼	...

* 12 drachms *Cocoa* may be substituted at morning or evening meals or at both; and Coffee or Tea may be substituted for the other at either meal.

IV.—WEEKLY SCALE OF DIET FOR A MALE ATTENDANT.

*	No. of Days ⅌ Week	Weight in oz. Avoirdupois: Allowance ⅌ Day	Weight in oz. Avoirdupois: Regular Weekly Allowance	Weight in oz. Avoirdupois: Additional & occasional Allowance
1.—Butcher Meat * †—				
a. To Dinner. Roast, baked, boiled, or stewed, partly in form of Meat Pie,(1)	5	13	65	...
b. To Dinner. Do. & Irish stew,(2)	1	8	8	...
c. To Dinner. In Soup or Broth, ...	7	1	7	...
			80	...
* Deduction for bone, fat, and refuse, from 32 to 33 per cent., or	...	...	26	...
Nett, ...	...	...	54 ‡	...
† Includes fresh Beef, Mutton, and Pork; as well as Bacon—all of best quality.				
2.—Rabbits—To Dinner—stewed, or in Pie—(after deduction of about 20 per cent. for bone, &c.),	1	14	14	...
3.—Fish—white (including Haddock, Cod, Flounder, and Herring; and Salt Fish—Cod and Ling)—To Dinner, ...	1	10	10	...
4.—Bread—white—best wheaten—				
a. To Dinner, Breakfast, Tea, and Supper, ...	7	24	168	...
b. ,, Do., in lieu of Potatoes, ...	1	8	..	8
			176	...
5.—Wheaten Flour—best American—				
a. To Dinner. In Meat and Fruit Pie crust, ...	2	2½	5	...
b. To Dinner. ,, Suet Dumpling, ...	1	3	...	3
			8	...
6.—Barley—Pearl—best Scotch—To Dinner—in Broth or Soup, ...	5	1	5	...
7.—Potatoes—best Scotch—To Dinner, ...	7	20	140	...
8.—Vegetables-miscellaneous-(including those specified in the Pauper and Intermediate Dietaries)—				
a. To Dinner. In Broth or Soup, ...	7	3	21	...
b. To Dinner. With Meat, ...	3	4	12	...
c. To Dinner. In lieu of Potatoes—occasionally,	2	4	...	8
			41	...
9.—Fruit, miscellaneous—(including that specified in the Pauper and Intermediate Dietaries)—				
a. To Dinner. In Fruit Pie, (3)	1	9	9	..
b. To Dinner. Do., in lieu of Pudding—occasionally, ...	1	9	...	9
c. To Dinner. ,, Jam Tart (as Jam or Jelly), do.,	1	4	...	4
d. To Dinner. As Dessert—in Summer ...	3	5	15	...
			37	...

1. *Meat Pie* consists of 6 oz. Meat, 3 oz. Flour, 1 oz. Lard, per person.
2. *Irish Stew* consists of 8 oz. Meat, 5 oz. Potatoes and Onions, &c., per person.
3. *Fruit Pie* consists of 3 oz. Fruit, 1½ oz. Flour, 1 oz. Lard, 1 oz. Sugar, ,,

‡ A close examination of the two series of Tables relating to the Dietaries of this Institution will disclose certain minor differences or discrepancies in the figures, which admit of easy and satisfactory explanation. The one series represents regulation scales or allowances, arranged on the principle of the average quantities supposed to be necessary for the due nutrition of healthy sane adults. The other sets forth the actual consumpt of the patients,—a consumpt which implies deviations,—depending on variations in the circumstances or requirements of the consumers,—from the standards contained in the old printed Diet Tables of the Institution. The one set of Tables gives a calculation of averages: the other exhibits the results of experience. And that differences must of necessity exist under such circumstances,—in any system of judicious and liberal dietetics, where the real interests of the patients are not sacrificed to official routine and regulation,—has been amply shown in the body of this Report, under the section on Asylum Dietetics.

IV.—WEEKLY SCALE OF DIET FOR A MALE ATTENDANT.

	No. of Days ⅌ Week	Weight in oz. Avoirdupois: Allowance ⅌ Day	Weight in oz. Avoirdupois: Regular Weekly Allowance	Weight in oz. Avoirdupois: Additional & occasional Allowance
10.—Peas—split—dry—best Scotch—To Dinner—in Pea Soup, ...	1	3	3	...
11.—Rice—best Patna—(including Ground Rice),				
a. To Dinner. In Soup, ...	1	1½	1½	...
b. To Dinner. Do., in lieu of Barley, ...	1	1½	...	1½
c. To Dinner. In Rice Pudding, (4)	1	1½	1½	...
			4½	...
12.—Sugar—best Brown—				
a. To Breakfast and Tea, ...	7	$2\frac{2}{7}$	16	...
b. ,, Dinner. In Tarts or Puddings, ...	2	2	4	...
c. ,, Dinner. Do.	1	2	...	2
			22	
13.—Butter—best Salt—Scotch—				
a. To Breakfast and Tea, ...	7	$1\frac{5}{7}$	12	...
b. ,, Dinner—in Pie crust, and Fish Sauce,	1	½	½	...
			12½	...
14.—Suet, Fat, Lard, &c.—				
a. b. To Dinner. In Broth or Soup—(Dripping, Marrow, &c.), ...	7	½	3½	...
c. To Dinner. ,, Suet Pudding, ...	1	2	2	...
d. To Dinner. ,, Pie crust, ...	2	1¼	2½	...
To Dinner. ,, Do.	1	2	...	2
			10	...
15.—Milk—best sweet—sp. gr. 1030·5—				
a. To Breakfast and Tea, ...	7	10	70	...
b. ,, Dinner—with Pudding, ...	1	15	...	15
			85	...
16.—Cheese—best Gouda—				
a. To Lunch—occasionally, ...	6	2	...	12
b. ,, Supper, ...	7	2	14	...
			26	...
17.—Porter—best Scotch—				
a. To Dinner, ...	7	10	70	...
b. ,, Supper, ...	7	10	70	...
c. ,, Lunch—occasionally, ...	6	10	...	60
			200	...
18.—Tea,*—To Breakfast and Tea, ...	7	4½ dr	2oz	...

4. *Rice Pudding* consists of 1½ oz. Rice, ½ oz. Sugar, 10 oz. Milk, per person.
Currant Dumpling or *Pudding* consists of 3 oz. Flour, 1 oz. Currants and Spice, 1 oz. Sugar, 1½ oz. Suet, per person.
Jam Dumpling or *Pudding* consists of 3 oz. Flour, 1 oz. Jam, 1 oz. Suet, per person.

* Some attendants have an allowance of Porridge and Milk in addition to Tea diet at morning or evening meals.

When on Night duty attendants or servants have extra allowances of Meat, Eggs, Bread, Beer or Porter, Tea or Coffee, &c.

In addition to Breakfast, Dinner, and Tea, at the same hours as those of the patients (the latter meal corresponding to the Supper of the patients), the attendants and servants have Supper proper between 8 and 10 P.M.

I.—*MAXIMUM* SCALE FOR OUT-DOOR WORKING *MALE* PAUPERS.

	Allowance in oz. Avoirdupois. Daily. No. of Days ℔ Week.	Daily. No. of oz. ℔ Day.	Weekly. No. of oz. ℔ Week.	Weekly. Total oz. ℔ Week.
1.—Meat (1)—cooked (2)—Dinner, ...	5	4 to 6	22	...
Exclusive of bone—cooked—in Barley Broth, or Pea Soup, ...	5	2	10	32
2.—Cheese—Lunch (3), ...	7	2	14	...
Dinner—with Bread, Milk, and Potatoes,	1	2	2	16
3.—Milk—new or sweet—to Porridge—Breakfast,	7	10	70	...
Do. Supper, ...	7	10	70	...
With Cheese, Bread, and Potatoes—Dinner, ...	1	8	8	148
4.—Bread—Lunch, ...	7	3	21	...
Dinner, ...	6	6 to 8	44	65
5.—Oatmeal—in Porridge—Breakfast, ...	7	6	42	...
Supper, ...	7	6	42	...
in Meal Pudding—Dinner, ...	1	6	6	90
6.—Barley- in Barley Broth—Dinner, ...	3	2	...	6
7.—Peas—whole or split, 2 oz., Pease Flour, 1½ oz. } in Pea Soup,	2	3·50	7·00	...
whole or split—in Barley Broth, ...	3	0·50	1·50	8·50
8.—Suet—in Meal Pudding—Dinner, ...	1	2·50	...	2·50
9.—Potatoes (2)—Dinner, ...	2	8 to 16	...	24
10.—Vegetables—(Onions,(2) Carrots, Turnips, &c.)—Dinner—				
In Barley Broth, ...	3	1·50	4·50	...
„ Pea Soup—(including "Seasoning"), ...	2	1·00	2·00	...
„ Meal Pudding (Onions), ...	1	0·75	0·75	...
With Meat (as "Greens" or Salad), ...	1	8·00	8·00	15·25
11.—Beer—Lunch, ...	7	10	...	70

1. "On one day in the week 8 oz. Fish may replace 4 oz. Meat; but Fish shall be served at least once a month."
2. Occasionally served as Irish Stew; or as Meat and Potato Pudding.
3. 3 oz. Meat may be substituted.

* Contained in the "Rules and conditions,—approved by one of H. M. Principal Secretaries of State,—on which the Board" (of Lunacy for Scotland) "will grant their Licenses for the reception of Pauper Lunatics into the Lunatic Wards of Poorhouses": Confirmed by Sir George Grey, 30th September, 1862, and sanctioned by Dr Christison, Professor of Dietetics and Materia Medica in the University of Edinburgh: Published in the 5th Annual Report of the General Board of Commissioners in Lunacy for Scotland: Edinburgh, 1863. Page 212.

† Re-arranged from the originals for the purposes of comparison with the other Diet Tables here given.

II.—*MINIMUM* OR ALTERNATIVE SCALE FOR ALL OTHER CLASSES OF *MALE** PAUPERS.

	Allowance in oz. Avoirdupois. Daily. No. of Days ℔ Week.	Daily. No. of oz. ℔ Day.	Weekly. No. of oz. ℔ Week.	Weekly. Total oz. ℔ Week.
1.—Meat (1) (2) (3)—cooked—Dinner, ...	5	4 to 6	22	...
exclusive of bone—in Barley Broth, ...	4	2·00	8	
in Pea Soup, ...	1	2·00	2	32
2.—Cheese—Dinner, ...	1	2·00	...	2
3.—Milk—a. new or sweet milk—Dinner, ...	1	8·00	8	...
Supper-Tea or Coffee,	7	1·00	7	15
b. Butter milk—Breakfast, ...	7	15		105
4.—Bread—Dinner, ...	2	6	12	...
Supper, ...	7	8	56	68
5.—Oatmeal—in Porridge—Breakfast, ...	7	6	...	42
6.—Wheaten Flour—in Suet Dumpling—Dinner, ...	1	6	...	6
7.—Barley- in Barley Broth—Dinner, ...	4	2	...	8
8.—Rice—in lieu of Potatoes—Dinner, ...	1	4	...	4
9.—Pease—whole or split, 2 oz., Pease Flour, 1·50 oz. } in Pea Soup, } Dinner,	1	3·50	3·50	...
whole or split—in Barley Broth— }	4	0·50	2·00	5·50
10.—Sugar—to Tea or Coffee—Supper, ...	7	0·50	...	3·50
11.—Suet—in Suet Dumpling—Dinner, ...	1	2·50	...	2·50
12.—Potatoes (1) (2)—in lieu of Bread—Dinner, ...	3	16	48	...
	1	16	16	...
	1	8	8	72
13.—Vegetables—(Onions, (1) Carrots, Turnips, &c.)— Dinner.				
In Barley Broth, ...	4	1·50	6·00	...
„ Pea Soup—(including "Seasoning"),	1	1·00	1·00	...
With Meat, ...	1	8·00	8·00	15·00
14—Tea (4)—Supper, ...	7	0·12	...	0·84

1. Occasionally served as Irish Stew.
2. Do. Meat and Potato Pudding.
3. "On one day in the week 8 oz. Fish may replace 4 oz. Meat; but Fish shall be served at least once a month."
4. Coffee—0·25 oz. may be substituted per day—*i.e.*, 1·75 oz. per week.

* There are the following differences between the *Female* and Male dietaries:—Females have about 16 per cent. less Oatmeal than Males to Breakfast and Supper daily; 16 per cent. less Meal Pudding or Suet Dumpling one day per week; and 25 per cent. less Bread to Supper daily, if Tea and Coffee diet is preferred to Porridge. They have the option of Tea or Coffee diet to Breakfast as well as Supper; and with Tea or Coffee diet morning and evening they have 3·50 oz. Butter per week (which is equivalent to an addition of 3·33 oz. of carboniferous nutriment per week, or 0·48 oz. per day).

VI.—SHOWING THE NUTRITIVE VALUE OF THE DIETARIES* FOR THE LUNATIC WARDS OF POOR-HOUSES.

I.—*MAXIMUM* WEEKLY SCALE FOR OUT-DOOR WORKING *MALE* PAUPERS.

	Allowance of Food in oz. Avoirdupois	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboniferous.	Total Solid Nutriment.
1. Meat, ...	32·00	4·80	7·68	12·48
2. Cheese, ...	16·00	7·68	4·80	12·48
3. Milk—new or sweet, ...	148·00	5·92	11·84	17·76
Butter milk, ...	...	...	...	...
4. Bread, ...	65·00	5·20	33·80	39·00
5. Oatmeal, ...	90·00	15·30	63·90	79·20
6. Wheaten Flour, ...	...	...	...	...
7. Barley, ...	6·00	0·84	4·32	5·16
8. Rice, ...	...	...	...	...
9. Pease, ...	8·50	2·04	5·02	7·06
10. Sugar, ...	...	...	...	...
11. Suet, ...	2·50	...	2·50	2·50
12. Potatoes, ...	24·00	0·48	6·00	6·48
13. Vegetables — (Onion, Carrot, Turnip), ...	15·25	0·46	2·29	2·75
Mean *daily* allowance per person,	...	6·10	20·31	26·41

* As given in the foregoing Table V:—the calculations being based on our Standard Table of Nutriment.

II.—*MINIMUM*, OR *ALTERNATIVE* WEEKLY SCALE FOR ALL OTHER CLASSES OF *MALE* PAUPERS.

	Allowance of Food in oz. Avoirdupois	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboniferous.	Total Solid Nutriment.
1. Meat, ...	32·00	4·80	7·68	12·48
2. Cheese, ...	2·00	0·96	0·60	1·56
3. Milk—new or sweet, ...	15·00	0·60	1·20	1·80
Butter milk,* ...	105·00	6·30	2·10	8·40
4. Bread, ...	68·00	5·44	35·36	40·80
5. Oatmeal, ...	42·00	7·14	29·82	36·96
6. Wheaten Flour, ...	6·00	0.84	4·26	5·10
7. Barley, ...	8·00	1·12	5·76	6·88
8. Rice, ...	4·00	0·24	3·52	3·76
9. Pease, ...	5·50	1·32	3·25	4·57
10. Sugar, ...	3·50	...	3·43	3·43
11. Suet, ...	2·50	...	2·50	2·50
12. Potatoes, ...	72·00	1·44	18·00	19·44
13. Vegetables, ...	15·00	0·45	2·25	2·70
Mean *daily* allowance per person,	...	4·38	17·10	21·48

* Estimated by Professor Christison's "Standard Table of Nutriment," 1849.

VII.—SHOWING THE NUTRITIVE VALUE OF THE DIETARIES (1) OF THE ROYAL INFIRMARY OF EDINBURGH: 1863.

	Daily Allowance per Patient in oz. Avoirdupois.		
	Solid * Animal Nutriment.	Solid Vegetable Nutriment.	Total Solid Nutriment.
1. Low Diet, ...	0·40	6·95	7·35
2. Rice Diet,†	1·45	6·40	7·85
3. Steak Diet,‡	1·41	13·77	15.18
4. Do. with Bread, ☞ ...	...	...	13·87
5. ⊙ Common Diet, ...	0·33	13·77	14·10
6. Do. with Bread, ☞ ...	...	...	13·56
7. ⊙ Full Diet, § ‖	3·85	15·17	19·02
8. Do. with Bread, ☞ ...	...	...	17·29
9. Extra Diet, ¶	4·85	18·58	23·43
Mean of the foregoing classes of Dietaries,	2·05	12·44	14·49

* All calculations are made on uncooked Food.
† Includes Beef Tea made from 8 oz. Meat.
‡ Do. Beefsteak, 4 oz.
§ Do. Boiled Beef after making Beef Tea. 6 oz.
¶ Do. do. do. 8 oz.
☞ Patients have their option between Porridge and Bread.
⊙ Common and full Diets are those principally used.
‖ *Vide* immediately following Table VIII.

1. The said Dietaries were arranged by a Committee of the Medical Managers and Medical Officers of the Institution "so as to *combine fitness, simplicity and economy.*"

VIII.—SHOWING THE ITEMS, AND NUTRITIVE VALUE, OF THE *FULL DIET* OF THE ROYAL INFIRMARY OF EDINBURGH—ACCORDING TO PROFESSOR CHRISTISON.

[BEING ONE OF THE TABLES USED IN HIS *LECTURES ON DIETETICS* IN THE UNIVERSITY OF EDINBURGH: 1849].

	Daily Allowance per Patient in oz. Avoirdupois.			
	Rough Weight of Food.	Nitrogenous.	Carboniferous.	Total Solid Nutriment.
1.—Breakfast—				
Oatmeal—(for Porridge), ...	4·50	0·73	2·96	3·69
Butter Milk, ...	20·00	1·20	0·20	1·40
2.—Dinner—				
Boiled Meat, ...	6·00	1·10	0·90	2·00
Potatoes, ...	16·00	0·40	4·32	4·72
Bread, ...	3·00	0·50	1·97	2·47
Broth, 20 oz. { Vegetables,	0·72	0·01	0·06	0·07
Broth, 20 oz. { Barley,	1·00	0·15	0·67	0·82
Broth, 20 oz. { Meat,	2·00	0·40	0·30	0·70
3.—Supper—				
Potatoes, ...	16·00	0·40	4·32	4·72
New Milk, ...	10·00	0·45	0·80	1·25
Total Daily allowance of dry or solid Nutriment, ...	...	5·34	16·50	21·84

IX.—EXTRACT FROM A TABLE OF PUBLIC DIETARIES AND THEIR NUTRITIVE VALUE, BY DR LETHEBY.*

	Weekly Allowance of Food in oz. Avoirdupois.							Proportion of Dry or Solid Nutriment. Daily Allowance in oz. Avoir.		
	Bread or Biscuit.	Meat.	Potato.	Meal, &c.	Milk.	Cheese.	Butter.	Nitrogenous.	Carboniferous.	Total Solid Nutriment.
1. Dietaries of Public General Hospitals, ...	93	52	56	14	7	...	3·2	3·5	12·1	15·6
2. Physiological requirements of the system in health,	140	84	...	...	...	...	3·5	4·0	12·7	16·7
3. Dietaries of Public Lunatic Asylums, ...	114	23	68	13	14	7	1·3	4·9	13·2	17·2
4. Do. the Navy, ...	112	112	56	...	...	...	...	5·0	17·7	22·7
5. Do. the Home Army, ...	168	84	112	...	...	...	...	4·8	19·4	24·2
6. Do. Berwickshire labourer, ...	122	...	...	224	224	...	...	7·0	37·1	44·1
7. Do. Yorkshire do., ...	280	126	28	...	210	...	49	8·8	42·2	51·0
Mean of foregoing 7 classes of Dietaries, ...	147	68	45	35	65	1	8	5·30	22·05	27·35
DIETARIES OF MURRAY'S ROYAL INSTITUTION CONTRASTED WITH THE FOREGOING.										
1. Paupers—male—working, ... } Patients.	104	35	68	51	133	6	2	5·17	22·55	27·72
2. Intermediate classes, ... } Patients. ...	126	40	112	2	39	1	7	3·94	21·77	25·71
3. Higher do., ... } Patients.	126	48	98	2	50	2	9	4·57	23·27	27·84
4. Average of all classes of Patients, } ...	98	27	104	36	67	2	4	4·30	20·82	25·12
5. Attendants and Servants, ...	140	60	140	...	70	14	10	5·52	25·43	30·95
Mean of foregoing 5 classes of Dietaries, ...	119	42	104	18	72	5	6	4·70	22·77	27·47

* Officer of Health and Food-Analyst to the City of London: contained in a Paper on the "Economy of Food," read before the Society of Arts in 1857. ("Medical Times and Gazette," March, 28, 1857.)

X.—SHOWING THE NUTRITIVE VALUE OF PUBLIC DIETARIES—ACCORDING TO DR LANKESTER. *†

	Daily Allowance per Person of Solid Nutriment in oz. Avoirdupois.		
	Nitrogenous.	Carboniferous.	Total Solid Nutriment.
1. Soldiers—British—general army on active service, ...	5·00	10·00	15·00
— — Royal Engineers—home service, ...	4·90	13·00	17·90
— — Chelsea Pensioners, ...	4·00	9·75	13·75
— French—on active service,	4·75	12·00	16·75
2. Sailors—British—on active service—Fresh Meat Dietary, ...	5·00	10·00	15·00
— — — Salt Meat Dietary,	6·00	12·00	18·00
— — Greenwich Pensioners, ...	3·50	10·00	13·50
3. Paupers-average of all British Workhouses,	3·15	8·25	11·40
4. Old men in Gillespie's Hospital, Edinburgh,	3·00	10·00	13·00
5. Boys—Christ's Hospital, ...	2·50	7·00	9·50
— Royal Normal School, Greenwich,	2·50	7·50	10·00
Mean of the foregoing 11 classes of Dietaries,	4·02	9·96	13·98
DIETARIES OF MURRAY'S ROYAL INSTITUTION CONTRASTED.			
1. Paupers—male working, ... } ...	5·17	22·55	27·72
2. Intermediate classes, ... } Patients.	3·94	21·77	25·71
3. Higher do., ... }	4·57	23·27	27·84
4. Average of all classes, ... } ...	4·30	20·82	25·12
5. Attendants and servants, ...	5·52	25·43	30·95
Mean of foregoing 5 classes of Dietaries,	4·70	22·77	27·47

* "Guide to the Food Collection in the South Kensington Museum," 2nd edition, London, 1860, page 55: which "Guide," as well as his lectures "On Food," delivered at the South Kensington Museum, London, 1862, we would commend to the perusal of all interested in Dietetics. Our acknowledgments are due to the author for his friendly communications on the subject of these inquiries,

† *Vide* foot note appended to Table XI.

XI.—SHOWING THE PROPORTION OF NITROGENOUS TO CARBONIFEROUS ELEMENTS OR CONSTITUENTS OF FOOD IN VARIOUS PUBLIC OR OTHER DIETARIES.

	Nitrogenous.	Carboniferous.
1. Physiological requirements of healthy system—average of both sexes of adults according to Liebig and Gregory, ...	1 to	5·00
Do. do. Letheby, ...	1 ,,	3·17
Do. adult working males—mean of 2 estimates,	1 ,,	4·21
2. Public General Hospitals or Infirmaries (Letheby), ...	1 ,,	3·45
Royal Infirmary of Edinburgh Full Diet (Christison) ...	1 ,,	3·08
3. Paupers—general average of British (Lankester), ...	1 ,,	2·61
4. Berwickshire labourers (Letheby),...	1 ,,	5·30
5. Yorkshire do. (do.), ...	1 ,,	4·79
6. Army—British—home Service (do.), ...	1 ,,	4·04
— — active Service (Lankester),	1 ,,	2·00
— — Royal Engineers—home Service (do.), ...	1 ,,	2·65
— — Chelsea Pensioners (do.), ...	1 ,,	2·43
— French—active service (do.), ...	1 ,,	2·53

	Nitrogenous.	Carboniferous.
7. Navy—British—(Letheby).	1 to	3·54
— —(active service—fresh or salt meat diet)—(Lankester),*	1 ,,	2·00
Greenwich Pensioners ... ... (do.),	1 ,,	2·85
8. Public Lunatic Asylums (Letheby).	1 ,,	3·30
9. Lunatic Wards of Poorhouses in Scotland—		
Minimum according to clause 11 of the "Regulations"—Males,	1 ,,	3·00
Females,	1 ,,	2·60
Mean of both Sexes, ...	1 ,,	2·80
Maximum—(deducted from Diet Tables)—for out-door working males, ...	1 ,,	3·32
For all other classes of males,	1 ,,	3·90
Mean of foregoing Maxima and Minima,	1 ,,	3·56
Mean of Dietaries for Lunatic Wards of Scotch Poorhouses,...	1 ,,	3·19
10. MURRAY'S ROYAL INSTITUTION—		
Patients. Paupers—Males—working, ...	1 ,,	4·36
Patients. General average—Males, } Estimate of Dr Murray	1 ,,	3·23
Patients. Females, } Thomson, ...	1 ,,	3·43
Patients. Intermediate classes, ...	1 ,,	5·52
Patients. Higher do., ...	1 ,,	5·09
Patients. Average of all classes, ...	1 ,,	4·84
Staff. Attendants and Servants, ...	1 ,,	4·60
Staff. Officers, ...	1 ,,	4·60
Staff. Physician, ...	1 ,,	4·48
Mean of Patients' Dietaries, ...	1 ,,	4·41
Do. Dietaries for Staff, ...	1 ,,	4·56
Do. both series or classes of Dietaries, ...	1 ,,	4·48

* The discrepancy between the estimates given by Dr Lankester (*Vide* Table X.) and those given by Dr Letheby (*Vide* Table IX.) and other authorities is so marked—especially in relation to the proportion between the carboniferous and nitrogenous nutriment in Public Dietaries, that we are forced to the conclusion that they have been calculated on different bases or data. In any view,—under any circumstances—Dr Lankester appears to give,—as contrasted with other authorities—an excessive proportion of nitrogenous in relation to carboniferous materials: in some cases amounting to about *double* the estimate formed by others.

XII.—SHOWING THE AVERAGE WEEKLY CONSUMPT PER PERSON OF ALL CLASSES OF PATIENTS.*

	Actual Consumpt of Food in oz. Avoirdupois	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboniferous. †	Total Solid Nutriment.
1. Meat *a*—Beef, Mutton, Pork,	27 (1) }	4·35	6·96	11·31
b.—Poultry, Rabbits, and Game, ...	2 (2) }			
c.—White Fish, ...	17	2·55	1·19	3·74
2. Eggs, ...	5	0·65	0·60	1·25
3. Cheese, ...	2	0·96	0·60	1·56

* Including the workers and the idle; the strong and the infirm; the sedentary and the active—of both sexes.
1. After deducting about one-third or 33 per cent. for Bone, Suet, &c.
2. Do. one-fifth or 20 per cent. for Bone, &c.
† Including *Salts* or *Mineral* constituents of Food.

	Actual Consumpt of Food in oz. Avoirdupois	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboniferous.	Total Solid Nutriment
4. Milk—sweet—sp. gr. 1030·5—average, 1032, ...	67	2·68	5·36	8·04
5. Bread, ...	98	7·84	50·96	58·80
6. Oatmeal, ...	36	6·12	25·56	31·68
7. Wheaten Flour, ...	4	0·56	2·84	3·40
8. Barley, ...	4	0·56	2·88	3·44
9. Rice, Sago, &c., ...	2	0·10	1·72	1·82
10. Pease—split, ...	3	0·72	1·77	2·49
11. Sugar, ...	7	...	6·86	6·86
12. Butter, ...	4	...	3·80	3·80
13. Fat, Suet, and Lard, ...	4	...	4·00	4·00
14. Potatoes, ...	104	2·08	26·00	28·08
15. Miscellaneous Vegetables,	27 }	0·93	4·65	5·58
16. Do. Fruit, .	4 }			
Mean *daily* consumpt, ...	...	4·30	20·82	25·12

XIII.—SHOWING THE AVERAGE *WEEKLY* CONSUMPT PER PERSON OF ALL CLASSES OF PATIENTS ABOVE THE RANK OF *PAUPERS*.

	Intermediate Classes.*				Higher Classes.*			
	Actual Consumpt of Food in oz. Avoir.	Per Centage of Solid Nutriment in oz. Avoirdupois.			Actual Consumpt of Food in oz. Avoir.	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboniferous.	Total Solid Nutriment.		Nitrogenous.	Carboniferous.	Total Solid Nutriment.
1. Meat—*a*.—Beef, Mutton, Pork, ...	40 (1)	6·00	9·60	15·60	48 (1)	7·20	11 52	18·72
b.—Poultry, Rabbits, and Game, ...	8 (2)	1·20	1·92	3·12	8 (2)	1·20	1 92	3·12
c.—White Fish, ...	20	3·00	1·40	4·40	28	4·20	1·96	6·16
2. Eggs, (3) ...	...	...	...	...	8	1·04	0 96	2·00
3. Cheese, ...	1	0·48	0·30	0·78	2	0·96	0·60	1·56
4. Milk, ...	39	1·56	3·12	4 68	50	2·00	4·00	6·00
5. Bread, ...	126	10·08	65·52	75·60	126	10·08	65·52	75·60
6. Oatmeal—(in "cakes,")	2	0 34	1·42	1·76	2	0·34	1·42	1·76
7. Wheaten Flour,...	2	0·28	1·42	1·70	3	0·42	2·13	2·55
8. Barley,... ...	5	0·70	3·60	4·30	3	0·42	2·16	2·58
9. Rice, Sago, &c., ...	3	0·15	2·55	2·70	4	0·20	3·40	3·60
10. Pease—split, ...	2	0·48	1·18	1·66	2	0·48	1·18	1·66
11. Sugar, ...	17	...	16·66	16·66	20	...	19·60	19 60
12. Butter,... ...	7	..	6·65	6·65	9	...	8·55	8·55
13. Fat, Suet, and Lard,	4	...	4·00	4·00	6	...	6·00	6·00
14. Potatoes, ...	112	2·24	28·00	30·24	98	1·96	24·50	26·46
15. Miscellaneous Vegetables, ...	30 }	1·02	5·10	6·12	42 }	1·50	7·50	9·00
16. Miscellaneous Fruits,	4 }				8 }			
Mean *daily* consumpt,	...	3 94	21·77	25·71	...	4·57	23·27	27·84
Abstract showing the relative Proportions of Animal and Vegetable Food and Nutriment—								
I.—ANIMAL.								
a. Per Week, ...	119·00	12·24	26 99	39·23	159·00	16·60	35·51	52·11
b. ,, Day, ...	17·00	1·75	3·85	5·60	22·71	2·37	5·07	7·44
II.—VEGETABLE.								
a. Per Week, ...	303·00	15·29	125·45	140·74	308·00	15·40	127·41	142·81
b. ,, Day, ...	43·28	2·19	17·92	20·11	44·00	2·20	18·20	20·40

* Mean of both sexes: including the idle and infirm as well as the industrious and robust,
1. After deducting about one-third or 33 per cent. for Bone, Suet, &c.
2. Do one-fifth or 20 per cent. for Bone, &c.
3. When on sick list or Extra diet—in form of Pudding or otherwise.

XIV.—SHOWING THE AVERAGE *DAILY* CONSUMPT OF EACH PAUPER PATIENT:*

ESTIMATE BY DR MURRAY THOMSON, F.R.S. EDINB.

	Per Centage of Solid Nutriment in oz. Avoirdupois.		
	Nitrogenous.	Carboniferous.	Total Solid Nutriment
I.—MALES.			
1. Breakfast, 8 A.M., ...	1·50	3·75	5·25
2. Dinner, 1 P.M., ...	2·50	8·50	11·00
3. Supper, 6 ,, ...	1·25	4·75	6·00
Total per day, ...	5·25	17·00	22·25
II.—FEMALES.			
1. Breakfast, 8 A.M., ...	1·00	3·00	4·00
2. Dinner, 1 P.M., ...	2·00	6·75	8·75
3. Supper, 6 ,, ...	1·00	4·00	5·00
Total per day, ...	4·00	13·75	17·75
Mean of consumpt by Males and Females,	4·63	15·37	20·00

* Including the idle and feeble, as well as the able-bodied and actively employed. In round numbers there are 100 Paupers, 50 of either sex: of these 30 of either sex—that is about 60 per cent. are able-bodied and actively employed: the remaining 40 per cent. comprise the idle, the sedentary, the feeble, and the sick.

XV.—SHOWING THE AVERAGE WEEKLY CONSUMPT PER PERSON BY OFFICERS.*

	Actual Consumpt of Food in oz. Avoirdupois	Per Centage of Solid Nutriment in oz. Avoirdupois.		
		Nitrogenous.	Carboniferous.	Total Solid Nutriment.
1. Meat—a.—Butcher Meat, ...	48	7·20	11·52	18·72
b.—Poultry, Rabbits, and Game,...	6	0·90	1·04	1·94
c.—White Fish, ...	6	0·90	0·42	1·32
2. Eggs—(partly in Puddings, &c.),	20	2·60	2·40	5·00
3. Cheese, (1)	...	...	...	...
4. Milk—sweet—sp. gr. 1030-5,...	68	2·72	5·44	8·16
5. Bread, ...	47	3·76	24·44	28·20
6. Oatmeal, ...	5	0·85	3·55	4·40
7. Wheaten Flour, ...	15	2·10	10·65	12·75
8. Barley, ...	2	0·28	1·44	1·72
9. Rice, Sago, &c., ...	5	0·25	4.25	4·50
10. Pease—split, ...	1	0·24	0·59	0·83
11. Sugar, ...	18	...	17·64	17·64
12. Butter, ...	7	...	6·65	6·65
13. Fat, Suet, and Lard, ...	4	...	4·00	4·00
14. Potatoes, ...	37	0·74	9·25	9·99
15. Miscellaneous Vegetables,	21	0·63	3·15	3·78
16. Do. Fruits, ...	8	0·24	1·20	1·44
Mean *daily* consumpt, ...	...	3·34	15·38	18·72

* Resident Medical Assistant, Matron, and Housekeeper.
1. Optional; but in point of fact seldom or never used.

CHAPLAIN'S REPORT.

IN respectfully submitting to the Directors a brief account of the work of his department, the Chaplain has to report that the usual religious services have been uninterruptedly conducted since the period when he entered upon his office. These services, as the Directors are aware, consist of a Sabbath morning service similar to those in ordinary Christian congregations, and a service of the nature of family worship twice every week, on the mornings of Tuesday and Friday. On all these occasions, the attendance has been well maintained, the Chapel on Sabbath being ordinarily quite full, while the numbers present on week days, though more fluctuating, are, it is presumed, about as large as might be reasonably reckoned upon. The propriety and decorum manifested on the part of those in attendance is most marked and exemplary: not only has no instance of serious interruption at any time occurred, but the general aspect of those assembled bespeaks in most a subdued self-control, and in not a few a devout and reverential sense of the solemnity of the exercises in which they are engaged. The attention in many cases is no doubt fitful, and even when arrested is not easily retained, but on the part of some an evident and touching interest is taken both in the prayers and sermon, texts and subjects are kept in their memory, and remarks and illustrations are occasionally recalled in subsequent conversation. It has been the Chaplain's aim to select such subjects as are at once simple and soothing, and fitted to draw the mind out of itself to the contemplation of the great truths and animating hopes of Divine revelation, so as at once to cheer the downcast, stimulate the sluggish, and quicken by the Divine blessing a healthy and hopeful religious sentiment in all. Nor can he doubt that such services are so far appreciated as to supply a want which would otherwise be deeply felt by those who engage in them, and that the gentle excitement and necessary self-restraint occasioned by them, are fitted, independently of higher results, to have a wholesome effect on the tone of their mental and moral health.

In the course of his more private visitation, besides attending to the sick and such as may specially need religious counsel and sympathy, the Chaplain takes occasion to approach and converse with all the patients who, in the opinion of the Physician, are open to such intercourse. He has found this department of his duty, as may be conceived, not unattended with difficulty, and calling for no small measure of wisdom and discrimination in adapting his remarks to the very various characters and states of mind of those with whom he comes into contact. Tenderness and patience in listening to the tale of their vexations and sorrows, require to be combined with readiness and tact in leading the conversation out of the region of morbid fancies and ever-recurrent complaints into profitable and consolatory channels. Whatever may have been his success in this respect, the Chaplain is happy to believe that his visits are increasingly welcomed with pleasure, and he would trust, not altogether unaccompanied with beneficial results. He is encouraged to hope that growing familiarity with this delicate and interesting field of occupation, and a more intimate knowledge of individual peculiarities, will increase his facility in turning these valuable opportunities of intercourse to useful account.

During the past winter the usual classes of an educational nature have been in regular operation, under the same kind superintendence as formerly, viz.:—the class for the practice of sacred harmony, conducted by the Matron, on Monday evenings; the class for improvement in writing and arithmetic, conducted by the Housekeeper, on Tuesday evenings; and the Sabbath evening Bible class, under the charge of the same lady, assisted by an upper class patient. At all these classes, the attendance has continued at about its usual mark, and a gratifying degree of attention and progress has been manifested by the pupils. Near the close of the season, the Chaplain had the pleasure of examining the Bible class, and was delighted not only with the general order and decorum of the proceedings, but with the intelligent interest taken by many of the pupils in the work of the class, and the considerable familiarity with Scripture knowledge which some evinced. No happier or more appropriate method of enlivening the monotony of the Sabbath evening could have been devised, and he trusts that those who are thus engaged will feel increasingly encouraged to persevere in their benevolent labours.

The Chaplain cannot conclude this brief and necessarily meagre report, without expressing the very strong and grateful sense he entertains of the uniform courtesy and kindness, as well as efficient co-operation, which he has received from the officers and attendants of the Institution, with whom he feels it a privilege to be associated in assisting to promote in any degree its noble and beneficent objects, and upon all whose efforts to this end, as well as upon his own, and those of all who seek its prosperity, he prays that the blessing of the Almighty may ever conspicuously rest.

WM. D. KNOWLES, *Chaplain.*

REPORT

ON THE

GENERAL SANITARY CONDITION

OF

COWLEY INDUSTRIAL SCHOOL.

BY

HENRY W. ACLAND, M.D., F.R.S., &c.

Printed by desire of the Guardians of Oxford.

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1863.

Cowley Industrial School is the School for Pauper Children attached to the Oxford Union. It was intended to be a School for the surrounding district. Hitherto this desirable object has not been attained.

OXFORD,
March 12, 1863.

To the Guardians of the Poor within the City of Oxford.

GENTLEMEN,

I have the honour to acquaint you that, in conformity with the Resolution of the Board of Guardians communicated by your Chairman to me on February 25, I have examined the Industrial School at Cowley.

By the courtesy of the Chairman and of your Medical Officer I have visited it both with them and by myself, and it gives me pleasure to add that I have received the most ready assistance from the resident Officers of the Establishment.

It is hardly necessary to remark that the words of the Resolution, with I doubt not the fullest intention, imposed on me the duty of a full enquiry. To report "generally upon the sanitary condition" of a school is to give an opinion on all circumstances which can affect the health of the inmates: and this opinion is valueless, unless it be accompanied by a statement as to whether any and what alterations are desirable, in order permanently to secure the children's physical welfare.

There is in the Cowley School a condition of an anomalous nature, which makes it difficult to frame satisfactory recommendations while that condition lasts.

I allude to the fact that it was planned for more than 200 children and that there are now but 83. Consequently the capabilities of the Institution are undeveloped. This being so, it is not easy to conduct the internal arrangements for industrial work so as to ensure at once economy, education, and health.

I will endeavour to state clearly the points which called for investigation, and I will name under each head such modifications as appear to me desirable for the health of the children without defeating the objects of the founders of the School. After this has been done I shall venture to lay before you some of the general principles which have guided me in the observations I shall have made.

I found on the 26th of February among eighty-three children no less than thirty-four cases of skin disease. There were two distinct disorders—one a disease of the scalp, the other a general affection resembling Scabies in several stages, but so deficient in some of the ordinary characters as to make a positive conclusion as to its nature at first difficult. I have now had time to make the investigation necessary to arrive at this conclusion, and by signs which cannot be mistaken, viz. the detection of the ova of the *Sarcoptes hominis* (which I believe these ova to be), the presence of Scabies is established, however much it is masked by other serious pustular eruption and by boils. I have conferred with your Medical Officer on the medical management of these cases. They, as you know, have proved very tedious; and though often cured have often again relapsed.

There was, besides, in many children evidence of languid circulation, unfavourable to the development of either body or mind.

These conditions do not imply necessarily either neglect or mismanagement in any one department. But they do of course imply, either, that in one or more departments the arrangements are imperfect, or else, that the children themselves are incapable of attaining to health. It became therefore my duty to look into every particular of the scheme of the School. I may as well say at once that, on the whole, the management of the School is encouraging and satisfactory.

To point out by what kind of management we may hope to secure freedom from disease, and the future health of the children, is the object of what follows.

The sanitary condition of the School generally may be considered under the heads of

1. The Building and its Site.
2. Clothing and Cleanliness.
3. Food.
4. Occupations.
5. Hospital Accommodation.
6. Management and Expenditure.

1. THE BUILDING AND ITS SITE.

The history and general character of the School-buildings at Cowley are too well known to you to require minute details from me.

The house has a southern aspect, and stands on a small plateau of the Oolite, with gentle slopes to the South, the North, and the East. If the adjoining fields were in possession of the Guardians, they would afford ample scope for agricultural operations to any extent that the Guardians could require. But the ground most available for these purposes as regards the children—that is, the ground with the southern slope sheltered from the north—is not, I am informed, the property of the Guardians; whereas the northern plateau, exposed to all keen winds and quite unprotected, is their only available tillage-ground. This is, I think, a cardinal misfortune.

The arrangements of the interior of the dwelling are sufficiently good; the rooms are lofty, airy, capable of excellent ventilation, and of adequate warming by open fireplaces. The drainage demands attention. Soil-pipes are said to leak into the house, and the water supply is scanty in the Closets. The Drains moreover, so Mr. Bruton informs me, ought to be examined, and before this Report is presented, will have been inspected.

It is proposed to convey the sewage away from the present cesspools to a sewage distribution tank. Under proper management, and if the soil be sufficiently friable to absorb the liquid and to mix with the solid refuse, there is, I am inclined to think, no danger to be apprehended to the health of the house, from this change. Upon this point, and upon the question of how much sewage can be most profitably distributed on a given area, it is premature to speak with certainty[a]. The Guardians will, however, be justified, both on sanitary and economical grounds, in making the attempt of so re-arranging their drains, and by this method they will help to familiarize the agricultural lads with practical operations of this nature. It would be more easy to distribute the house sewage on the east and south, than on the plot now in hand to the north. If it be distributed to the north it must be pumped to a proper level. Already the children have, to say the least, enough work.

I have not felt called upon to examine the general

[a] See Reports of the Sewage Commission, 1858 and 1861, and Report of Select Committee on Sewage of Towns, 1862.

character of the shell of the building. But with respect to the ground-plan it appears to me that in two particulars it is defective.

(a) The Play-yards are to the north, and though partially sheltered by low buildings from the northerly winds which come unbroken over the plain, the children are during the whole winter deprived by the mass of the school-building of one essential of health—sunshine.

One of the first remedial measures should be a Playground to the south of the School.

(b) The Lavatories have no covered communication with the main body of the building.

It may be said generally of the several departments that they are airy, roomy, and suitable to their several purposes.

2. CLOTHING AND CLEANLINESS.

These two are considered together, as they are intimately connected.

The bleak position of the School, the absence of all protecting vegetation, the northern aspect of the playgrounds, the low physical type of the children, require that very special attention should be given to the Clothing; both in respect of its quality and quantity. In each of these the children appear to me to be treated with judgment; and their general appearance is creditable to those to whose care they are committed.

The Clothes are in good order and of substantial quality. I find that flannel next the skin is not worn, nor should I lay down as an absolute rule that it is necessary. But if it be not necessary for *all*, it is the more requisite to pay attention to the children individually, and to provide flannel waistcoats for some; but I believe as a rule that up to the age of seven they should have it. I shall have to state hereafter some general principles applicable to dress as to other subjects, so that I need only add now, that when the circulation is languid, when chilblains are frequent, when the physical type is markedly low, and especially when these characters co-exist in the youngest class of children, then flannel should be always ordered. For the younger children, up to five, flannel gowns are desirable for a night-dress; for the older this is unnecessary.

Essentially connected with the Clothing is the Cleanliness of person, of apparel, and of bedding.

The experience of the great Metropolitan Workhouses shews that low type children require more attention to cleanliness to keep them in health than children of a higher grade and of finer breed; and I make this remark at once to screen myself from the charge of over-refinement in what I am about to say. With all possible care, such children, removed from home and collected in masses, can scarcely be kept clean enough to secure such health as shall make them robust. Considerable attention is paid at Cowley to this point. The children all have a cold or warm bath once a week. This may be advantageously extended to twice. The general washing should be down to the waist daily, with an ample supply of water. It is indispensable that the washing-troughs should be renewed on a different plan. Trusty elder children should be responsible under direction for the thorough cleanliness of the lavatory and of the washing basins.

The Bed-linen and Beds have next to be considered. Whenever a bed is soiled the ticking should be removed and sent to the wash, and the flock be air-dried and

occasionally cleaned; or, which is better, the whole bed should be steamed in a closed chest, and afterwards dried in the hot-air closet. No sheets should be used for more than a fortnight. If soiled, they should be changed at once. If children are carelessly or wilfully unclean they should be punished, and should sleep on straw-chip beds, the straw being burnt as soon as soiled[b]. Blankets are to be washed as they appear to become dirty, or, at all events, once a-year. The boys should have their linen changed at the least twice in the week if they sleep in their day linen, once a week if they have night linen provided. Fire should be occasionally lighted by rotation in the dormitories for a few hours.

On occasion of the present enquiry all the clothes and all the bed-linen of every child that has had a cutaneous affection, or any clothes or bed-linen that have been used by any that have it, should be forthwith steamed or boiled, and fresh clothes should be served out as the children are reported to be cured. Meanwhile, there being ample space for the purpose, the children affected are to be kept separate till the cure and change of clothes has been completed.

3. FOOD.

For clearness' sake I append in the following table the diet which I should suggest for the present, stating the quantities in their *weekly* amounts. The upper line is the present dietary: the lower that which it is proposed to substitute for it.

[b] Mr. Tufnell tells me that cocoa fibre, which can be washed and replaced, answers well.

TABLE

Shewing the present and the proposed dietaries, in pints and ounces. The quantities are those allowed weekly.

COWLEY SCHOOL.	Bread.	Potatoes.	Greens, Turnips, or Carrots.	Mutton.	Beef.	Rice Pudding.	Butter.	Milk (pints).	Soup (pints).	Suet Pudding.	Porridge (pints).	Cheese.
Ages, 2 to 5.												
Present diet	61	18		6		8	$1\frac{3}{4}$	$5\frac{1}{4}$	1	8	0	0
Proposed diet	**61**	**16**	**16**	**6**	**6**	**8**	**$3\frac{1}{2}$**	**7**	**0**	**0**	**0**	**0**
Ages, 5 to 9.												
Present diet	78	24		9		0	$1\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$	10	$5\frac{1}{4}$	0
Proposed diet	**88**	**20**	**20**	**7**	**7**	**10**	**$3\frac{1}{2}$**	**$5\frac{1}{4}$**	**0**	**10**	**0**	**0**
Ages, 9 to 16.												
Present diet	98	24		12		0	0	$3\frac{1}{2}$	3	12	7	7
Proposed diet	**110**	**20**	**20**	**8**	**8**	**0**	**$3\frac{1}{2}$**	**$3\frac{1}{2}$**	**1**	**12**	**0**	**7**

The general principle upon which the changes recommended are based will be found to be an increase of meat, especially for the youngest class; an addition of green food; an increase of milk in the two younger classes; an addition to the bread of the two older classes; the abstraction of porridge from the two elder classes, and of suet pudding from the infants.

Experience has shewn, and will, I believe, in this case also prove, the value of such a Dietary here respectfully proposed to you. But in my judgment, no Dietary, however excellent, will suffice, unless accompanied by open-air exercise, and by, as far as can be secured, such mirthful life and child-like elasticity as can be obtained in a system necessarily and confessedly not favourable to the best development of the body and mind of a child. No diet whatever which is monotonous is safe for children. A little skilful management in varying the flavour and mode of cooking will often secure the

assimilation of a diet not absolutely so nutritious, as one which is left untouched in consequence of a natural instinct that demands variety.

4. OCCUPATIONS.

THE occupations generally proper for Industrial Schools are now so well defined as to require no elucidation here, save in so far as local or special circumstances bearing more directly upon health may tend to suggest modifications.

The half-time system gives ample opportunity for out-of-door work or play, if both of a suitable description be provided. Health being all in all to a working lad, and vital power being generally deficient in pauper children, sedentary industrial work, such as shoemaking and tailoring, are among the least desirable for health. Carpentery, stable or farm work, smithing, gardening are among the best for the boys, if they be not over-tasked; cooking, housework, washing are suitable for the girls. These for the most part develope the muscular system, and exercise usefully the mental qualities. Smithing is named as specially desirable, because an increasing number of lads can find places in connection with agricultural or other smaller steam engines, which are being largely brought into use throughout the country. A small steam engine for pumping water would, if the plan of irrigation with the sewage be carried out, be useful for the House; the man who managed it might be an industrial teacher in iron-working. A greater supply of water is wanted than the work of the lads should be expected to produce; and, as is the case at Annerley, the steam boiler might supply hot water and steam heat for the laundry, the kitchen, and the baths—one man superintending the whole and teaching the lads[c].

It has been already said that the play-grounds should be in the sun to the south: they might be fitted with plain and circular swings, and Norwegian poles, at trifling expense, and from this one change very good results might be anticipated.

The girls at Cowley are not quite so easily provided with useful and healthful occupations as the boys. They are not strong enough for washing, excepting in the case of a few, who can do the lighter parts. They may aid in the kitchen to some extent; but the wholesale cookery of a large establishment is comparatively useless to them afterwards. Two or three might with advantage be taught in turn to prepare on special cottage grates smaller portions of diet. They would soon acquire handiness and knowledge which would be of real use to them in after life, whether in service, or in their future homes[d].

I am but too well aware of the difficulty of organizing such details in a small establishment; but I feel it a duty nevertheless to record them because of their bearing on the cheerfulness, life, and so on the health, of the inmates. Could not unpaid help be found to aid in superintending work of this kind?

I will only say further with respect to the occupations

[c] I submit to the Guardians whether it might not be worth while to consider this addition to the establishment before deciding on the position of the sewage tanks. Should the School be much increased, there would be little doubt of the value of the arrangement.

[d] This arrangement was proposed for the convalescents of the Hospital in this place several years ago. If every provincial Hospital would act on it, in a very few years economical and palatable cottage cookery might be practised in thousands of poor homes.

that it has been found that Music is a source of the greatest pleasure, and, when on a large scale, of profit also to district workhouse schools. Of pleasure, because a cheerful band keeps up, as is well known on board ship, an elasticity attained in no other way; of profit, by training boys to be fit to enter good Bands. That can be only partially done under ordinary circumstances in a small school: but if music be attempted care should be taken to cultivate cheerful secular music as well as devotional.

5. HOSPITAL ACCOMMODATION.

The Hospital is to the north of the main buildings, exposed on all sides. The window in every ward faces the north; the passages only have a south aspect. The wards are inconveniently small. It is now difficult to make it a satisfactory building in any way. It would be better if certain partition walls were removed, and windows made to the south. In such a situation the wards ought to have been placed east and west. I am informed that diarrhœa arose some time since from a temporary defect in the drains, but this has been remedied and the illness has ceased. The children are well cared for by the Nurse; but her duty is now heavy.

6. MANAGEMENT AND EXPENDITURE.

At the outset I ventured to say that certain general principles would be stated as those that had guided me in this Report; and they will explain why I have entered on topics which may at first sight seem to be only collaterally connected with health.

The *first principle* of a Pauper School is, it may be presumed, to train the children in such a way as to make them so useful and so independent that they might be raised from the pauper class, and in future kept off the rates. Whatever falls short of this is at once scant charity and bad economy. If this be admitted, there follows *a second principle*, viz. that the low condition of the children of this class, who have no homes and are without hope, requires greater care, and in some respects higher training, physical and mental, than is sufficient for a class above them, and almost necessarily involves a larger proportional expenditure. I do not see how the necessary training is to be had in any school without considerable expense; and expense less than is sufficient is a simple waste.

It were unbecoming in me to illustrate these maxims at length where they are well understood. At the same time, the question referred to me could not be considered with advantage between us, unless you knew the point of view from which the School was considered by me as your medical adviser on this occasion. I entertain no doubt that a somewhat higher scale of food and of cleanliness and of care is required for these children, in order to keep out the disease from which they have so long suffered. It is in itself, as I said at the outset, an index of a low state of vitality, or of cleanliness, or of food, or of care, or of all together. If any of the Guardians should point at the existing dietary and the general scale of comfort, and remark that they are even now far higher than these children would have in their own homes, were they not of the pauper class; I can only answer that, true as that is, the loss of the freedom of home, the absence of the care of parents, and the deadening influence of unexercised affections, entirely counterbalance the supposed advantages in food, and air, and clothing; and that had the Guardians been wholly satisfied with their condition they would not have required the present inspection.

There is nothing in the condition of the children which leads me to doubt the soundness of the principle on which the Industrial School was founded. That it has hitherto failed in practically becoming, as was intended, a District School, is unfortunate; and yet it is no objection to the principle of such establishments. The nearer, indeed, it can be brought to its intended condition of a *large* school the better. Well-paid Officers with ample help when required, liberal diet, cheerful amusements outside the building, will keep the Hospital clear, and give good material back to society and independence.

At the same time, I beg leave to guard myself against even the appearance either of advocating the opinion that District Schools are in all places the only, or even the best, method for the education of pauper children; or of objecting to orphan pauper "Homes," if under adequate inspection, and to all Workhouse Schools. I have not been called upon to enter on those questions, but only to discuss the "Sanitary condition generally" of the Cowley Industrial School, which was devised for a District School; and I have had to consider whether there be causes for low health inherent in it. I think that there are no such inherent causes. If the judgment of the Guardians should lead them to conclude, on examining the details of this Report, that any alterations are desirable for the purpose of checking the tendency to low pustular affections for so long prevalent there, the most important points will be suggested in the following summary of what has been stated above. They are the general conditions requisite for the health of such inmates, in such a building, and under such conditions as those you have to regulate.

The Guardians will no doubt notice that I have not gone into financial statements, such being wholly beside the question of what it may be desirable to do, if it be possible. But then I take leave to add that I have suggested no expense but what I believe to be reasonable and judicious, and, should the School increase, also remunerative.

I. As respects the Dwelling and its site.
  1. The southern slope should be in the hands of the Guardians.
  2. The sewage may be turned on the land.
  3. Play-grounds to the south should be provided.
  4. The lavatory arrangements to be remodelled.

II. Clothing and Cleanliness.
  Flannel to be provided.
  Beds and clothes to be *steamed* as required.
  Linen frequently changed.

III. Diet,
  To be somewhat increased, and to be varied.

IV. Occupations.
  Tailoring and Shoemaking not in themselves so desirable as employment out of doors or not involving a sitting posture, such as Carpentry, Smithing, Gardening, &c.
  Cheerful recreations to be encouraged as such: music, drum and fife band, drilling, walks into the country.

V. Hospital,
  If School increases, to be remodelled.

VI. Expenditure.
  Experience has shewn that liberal expenditure and full numbers are essential for maintaining the vigour of children in District Schools, and for securing the ultimate objects of the Institutions.

It may be satisfactory to the Guardians to know that, notwithstanding the suggestions which it has been my duty to submit to their notice, I consider their School

capable of securing the highest sanitary condition for a considerable number of the class of children for whom it was destined.

It is a pleasure and a duty to acknowledge the ready kindness with which Mr. Carleton Tufnell, the accomplished Inspector for the Privy Council, has accompanied me over all the details of the Central London and North Surrey District Schools. I am greatly obliged to the Rev. S. V. Edwards, the Chaplain, to Dr. Coster, the Medical Attendant, and to the Superintendent of the Central London School: to the Rev. O. J. Vignoles, Dr. Wilkinson, and Mrs. Smith, of the North Surrey School; as well as to Mr. Harries of the Poor Law Board. Without the minute information these experienced persons were so good as to give me in the most obliging manner, I could not have decided without a much longer enquiry on several of the details that are here hinted at rather than fully described.

The Guardians are probably acquainted with the mass of information on the subject contained in the Evidence and Report of the Education Commission, in several volumes of the Poor Law Reports, and in that useful publication, the Journal of the Workhouse Visiting Society. It would have increased these few pages to unwieldy dimensions had I quoted these documents in detail on the several points I have named; or had I discussed in full all the reasons for or against what has now been advanced.

I have the honour to be,
Gentlemen,
Your most faithful Servant,
HENRY W. ACLAND.

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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 perinæo; 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, $\frac{34}{32}$ths. 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 colłumn, 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.

TABLE FORMED TO SHOW THE LIMITS OF AGE, STANDARD HEIGHT, AND GIRTH OF CHEST, OF RECRUITS,

Required by General Order, No. 806, dated Horse Guards, 14th January, 1862.

CORPS.	Limits of Age: Min. Years	Limits of Age: Max. Years	Limits of Height: Min. Inches	Limits of Height: Max. Inches	Minimum of Girth of Chest according to variations in Height in different Corps: For Height of	Girth of Chest must be
CAVALRY—						
Heavy	18	25	68	71	70 inches and upwards	35 inches
Medium	18	25	67	69	68 inches and under 70	34 "
Light	18	25	66	68	66 inches and under 68	33 "
MILITARY TRAIN	18	25	63	66	63 inches to 66 inches	34 "
ROYAL ARTILLERY—						
Gunners	18	25	67 & upwards		Same as Cavalry	Same as Cavalry
Growing Lads	17 under 18		66 & upwards		Not defined	Not defined
Drivers	18	25	64	66	64 inches to 66 inches	34 inches
Artificers	Not defined		66 & upwards		Not defined	Not defined
ROYAL ENGINEERS—						
Sappers	18	25	66 & upwards		Same as Cavalry	Same as Cavalry
Drivers	18	25	64	66	64 inches to 65 inches	34 inches
INFANTRY	17	25	66 & upwards		Same as Cavalry	Same as Cavalry
China, India, St. Helena & New South Wales	18	25	66 & upwards		Same as Cavalry	Same as Cavalry
Rifle Brigade and 60th Regiment	17	25	65 & upwards		66 inches and upwards	34 inches
CAPE MOUNTED RIFLES	16	18	60	63	Not defined	Not defined
Boys and Lads	14	16	In the proportion of One Boy to One Hundred Men. Height and Chest Measurement not defined.			
Ditto ditto for R. E.	14	15				

The Recruit is to be measured round the Chest in a line over the Nipples, with his arms placed straight above his head, the backs of his hands touching each other, and the edges of the feet close together, and at the same time made to count the numbers from one to ten, in a loud tone of voice and slowly. The Superintending Officer and not the Surgeon will be held responsible for the correctness of this measurement.

J. J. BENNETT (LATE FORBES AND BENNETT), PRINTER,
143, HIGH STREET, SOUTHAMPTON.

A CONTRIBUTION

TO THE

PATHOLOGY OF THE CRURA CEREBRI.

BY
HERMANN WEBER, M.D., F.R.C.P.,
PHYSICIAN TO THE GERMAN HOSPITAL.

[*From Volume XLVI of the 'Medico-Chirurgical Transactions,' published by the Royal Medical and Chirurgical Society of London.*]

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1863.

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Received Jan. 31st.—Read April 28th, 1863.

AFFECTIONS of the crura cerebri are on the whole of rare occurrence, and especially those which are uncomplicated with other affections of the brain and medulla oblongata, and which thus throw light on the functions and pathology of this portion of the brain. I, therefore, venture to communicate to the Society the following case of hæmorrhage into the left crus cerebri, and will afterwards compare the symptoms with those observed in similar cases, and with the results of vivisections.

Summary.—C. L—, a man, æt. 52, affected with disease of the aortic valves, and rigidity of the arteries, had headache and disturbed sleep during the last years of life; was about two months before death, suddenly seized with paralysis of the right side of the body, and of the muscles supplied by the third nerve of the left side; died of broncho-pneumonia, especially of the right side, after slight but perceptible improvement in the phenomena of paralysis.
Post-mortem examination.—Hæmorrhage into the internal

and inferior portion of the left crus cerebri, with partial degeneration of the third left nerve.

C. L—, æt. 52, a temperate man, of sedentary habits, had in his fortieth year severe rheumatic fever, since which time he frequently felt shortness of breath, and palpitation of the heart. During the last two or three years of his life he suffered occasionally, for days, from headache, and often had tinnitus aurium; but not to such a degree as to render him anxious. The sleep, too, which formerly had been sound, was of late often disturbed by anxious dreams.

On May 8th, 1862, soon after a moderate dinner, and immediately after having returned from a short walk, and having sat down on a chair, he felt suddenly giddy and faint; he said this in a rather indistinct voice to his wife, who "saw him get up from the chair with a pale and ghastly appearance, and in the same moment fall down on his right side." The wife at once endeavoured to raise him, but he again would have fallen, if she had not supported him "For a few minutes he seemed unconscious, and unable to speak in an intelligible manner, but he soon recognised those around him, and spoke distinctly, although his voice was rather thick. The face looked strange, the mouth was all on the left, and the eyes turned in different directions."[1]

After a few hours the patient was seen by Mr. Stuckey, of Wellclose Square, who found him perfectly conscious, and noticed a complete paralysis of the right side from the face to the toes, ptosis of the left upper eyelid, and squinting; the pulse weak and irregular. Mr. Stuckey ordered the patient to be kept perfectly quiet, and gave him draughts of citrate of ammonia. On May 9th, the bowels being costive, he gave, in addition, six grains of Pilul. Coloc. comp., with four of Pil. Hydrargyri.

On May 10th, I saw the patient in consultation with Mr. Stuckey, and took the following notes.

[1] The words between the inverted commas are, as nearly as possible, those of the wife, an intelligent woman, when she related to me the occurrence in the presence of Mr. Stuckey.

Patient is of middle stature, good muscular development, of rather dark complexion, and pale. Posture on back. Face considerably drawn to the left, the right side hanging and almost motionless. Drooping of the left upper eyelid, and distinct squinting. A more accurate examination of the eyes shows that the right obeys the will, while the left is entirely motionless except in two directions, viz., in the horizontal direction from inwards outwards (the movement being very limited, as the cornea even in the state of rest is turned outwards), and round its own axis, in such a manner as to move the white from the outer corner upwards, from above inwards, from the inner corner downwards, and from below outwards, but not in the opposite way, or in other words, from outwards upwards, but not downwards. The cornea of this eye (the left) is always turned perceptibly towards the external corner, and can by no force of the will be turned either to the centre, or upwards, or downwards. There exists, therefore, on the left side paralysis of the third nerve, with immunity of the fourth and sixth nerves.

Both pupils are rather wide; the left is however much wider than the right; both contract imperfectly under the influence of light, the left much more so than the right.

The vision with both eyes combined is not always correct. He relates himself that, since the seizure, most objects of moderate size have a kind of shadow at their left side; that small objects appear sometimes double, the image to the left being, however, much dimmer than the other; and that, when he looks more attentively at the object, the shadow or the second image disappears. Some experiments made by Mr. Stuckey and myself proved this description to be correct, and showed in addition that the error in vision occurred only in looking at objects in a certain distance, while the same objects when moved farther away, or nearer to the eyes, were seen correctly. Thus, a large pin hung up in the distance of about a foot from the middle line, was repeatedly seen double, with the dimmer object to the left, but when held up in a greater distance, or nearer to the eyes, it was always seen as only one object, and even in the distance of a foot it was seen single, as soon as the patient concentrated his attention on it.

Vision with the right eye alone is perfect; with the left eye alone it is less good; but yet print in moderately large characters is easily read when held at a certain distance. The range of distinct vision is much smaller for the left eye than for the right. Before the seizure both eyes had been, according to the patient's assurance, equally good.

The tongue, when protruded, points to the right side; the right half is furred, the left almost clean. The uvula is drawn to the left; the right half of the soft palate is pendulous.

The senses of smell, taste, and hearing are unaffected.

The sensibility of the right half of the face is much less acute than that of the left.

The right arm and leg are perfectly motionless, and their sensibility is very dull. The patient feels the paralysed limbs warmer, but to the hand no difference between the right and the left side is perceptible.

The muscles of the right side of the thorax, although not paralysed, act less vigorously under the influence of the will, than those of the left. Thus the left side measures from the middle of the sternum across the nipple to the spine after expiration $44\frac{1}{2}$ centimeters (about $17\frac{5}{10}$ inches), and expands during deep inspiration to $47\frac{1}{2}$ centimeters ($18\frac{7}{10}$ inches); the right side, measured in the same manner, yields after expiration 45 centimeters (about $17\frac{7}{10}$ inches), and expands during a deep inspiration to scarcely $47\frac{1}{4}$ centimeters (not quite $18\frac{7}{10}$ inches).[1]

The mental conditions are otherwise normal, but the sleep is much disturbed by anxious dreams. A dream

[1] The measurement was taken five times, and the expansion by a deep inspiration was always greater on the left side; the average difference was rather more than $\frac{1}{2}$ centimeter (rather more than $\frac{2}{10}$ths of an inch), the minimum being $\frac{1}{4}$th, the maximum rather more than $\frac{3}{4}$ths centimeter. During calm (involuntary) respiration no difference was perceived in the expansion of the two sides during inspiration, $1\frac{1}{2}$ centimeters (about $\frac{6}{10}$ths of an inch) being the average expansion of either side.

which almost regularly recurs is that of falling from a great height.

Deglutition normal; the action of the intestines is very sluggish; the bowels, which formerly had been regular, have not been moved since the day before the seizure, in spite of strong aperient medicines administered during the last two days.

The phenomena of respiration are normal in both lungs.

The examination of the præcordial regions manifests the signs of old disease of the aortic valves with hypertrophy of the left ventricle; the arteries are rather rigid; the pulse is 62 to 65 per minute, rather irregular, and has the jerking character peculiar to insufficiency of the aortic valves (regurgitation).

Micturition is unaffected. The urine is passed in moderate quantity, is acid, of high specific gravity (1030), deposits lithates, and contains neither albumen nor sugar.

Treatment.—Rest of mind and body. Head in raised position. Moderate amount of easily digestible food.

Pilul. Colocynth. comp. gr. x, ad gr. xv nocte, si opus sit.

On May 13th, I saw the patient again, and found the general health, the action of the heart, the lungs, the kidneys, and the skin, as on the 10th; the obstinate constipation continued up to this morning, when the bowels were moved for the first time, and only once, after fifteen grains of Pilul. Colocynth. comp. administered last night, and three ounces of Infus. Sennæ comp., with a drachm of sulphate of magnesia given early this morning. The tongue when protruded pointed still to the right, and the fur was limited to the right half. The muscles of the right side of the face were rather less relaxed than on the 10th; the action of the muscles of the left eye unchanged; that of the right arm and leg scarcely improved, the expansion of the right side of the chest, too, manifested still the same defect. The patient complained of spasm in the right leg, and especially in the great toe; all the toes were in a state of extension, but the great toe was most drawn back, and it required some force to bend them; there was, on the whole, some degree of rigidity in all the muscles of the right arm and leg which, however, became only perceptible when we tried to bend and extend them.

With regard to sensibility, the difference between the two sides, measured by Sieveking's aesthesiometer, was as follows. The distance of the two points necessary to cause distinct perception was,

	On the left side.	On the right side.
Chin	$\frac{3}{10}$ in. (7·6 mm.)	$\frac{6}{10}$ in. (15·2 mm.)
Middle of the cheek......................	$\frac{5}{10}$ in. (12·7 mm.)	$\frac{9}{10}$ in. (22·8 mm.)
Point of the index finger (palmar surface)	$\frac{1}{10}$ in. (2·54 mm.)	$\frac{4}{10}$ in. (10·1 mm.)
Middle of the back of the hand, longitudinal diameter	$1\frac{3}{10}$ in. (33·0 mm.)	4 in. (101·6 mm.)
Middle of the back of the hand, transverse diameter..................	$\frac{6}{10}$ in. (15·2 mm.)	$1\frac{3}{10}$ in. (33·0 mm.)
Middle of the back of the foot, longitudinal diameter	$1\frac{6}{10}$ in. (40·24 mm.)	Over 4 in. (over 101·6 mm.)
Middle of the back of the foot, transverse diameter	$1\frac{1}{10}$ in. (27·9 mm.)	$3\frac{6}{10}$ in. (91·6 mm.

The sensibility was tested on several other points of the limbs, and was everywhere found at least three times less acute on the right side than on the left. There was also a marked difference between the two halves of the trunk, but less great than between the limbs. If this examination had been made on the first day after the seizure, the difference between the two sides would probably have been much greater, as it appeared, not only to Mr. Stuckey and myself, but also to the patient, that some improvement had taken place in this respect during the last days.

Again the patient mentioned that he felt the right arm and leg warmer than the left; and although there was scarcely any difference perceptible to the hand, yet, by means of a finely divided thermometer (of Geissler in Berlin) the temperature in the right axilla, and in the bend of the elbow, was found 0·5° Centigrade (0·9° Fahr.) higher than in the same places of the left side, both arms having been covered in the same manner before the examination. In the right axilla the temperature was 37·0° Centigrade (98·6° Fahr.), in the left 36·5° Centigrade (97·7° Fahr.); in the bend of the elbow the figures were slightly lower.

The left pupil is about three times as wide as the right, the diameter of the latter appearing now quite normal, or even slightly narrower than usual; the contraction of the left pupil is less perfect than that of the right.

The vision, with both eyes combined, is less disturbed than it had been at first; there is now no double vision at all, and only rarely a shadow, although the axes of both eyes still diverge almost as much, if not quite as much as on the 10th. The vision with the left eye alone is still rather "hazy" and inaccurate, except for large objects and for certain distances; the accommodation with the right eye appears much more rapid and perfect than with the left.

Treatment—as before, substituting only Pilul. cambogiæ comp., for Pilul. Colocynth. comp.

On May 25th the face, with the exception of the eyes, is almost symmetrical when at rest, but when animated, as in conversation, the right side moves less than the left; the tongue is protruded almost in the middle line, pointing only slightly to the right; the fur on it is much more equally distributed; both sides of the soft palate are almost equal. The muscles of the left eye supplied by the third nerve are but slightly more active than they were on the 10th; the squinting is still quite distinct, although rather less so than before.

Has had repeatedly, during the last eight or ten days, a dull but not violent pain in the left temple and forehead; is now free from it.

The paralysis of the limbs as to motion is just perceptibly diminished, the patient being able to move the fingers and toes slightly; there is still some rigidity in the muscles of the right side; the muscular irritability, tested by electricity, seems rather greater in the paralysed than in the sound limbs, but the difference, if any, is scarcely perceptible.

The sensibility in the paralysed side is decidedly improved. The distance of the points necessary to cause distinct perception, is—

	On the left side.	On the right side.
Chin	$\frac{3}{10}$ in. (7·6 mm.)	$\frac{5}{10}$ in. (12·7 mm.), had been $\frac{4}{10}$ in. on May 13th.
Middle of cheek	$\frac{5}{10}$ in. (12·7 mm.)	$\frac{7}{10}$ in., or rather more (18 mm.), had been $\frac{6}{10}$ in. on May 13th.
Point of index finger, palmar surface	$\frac{1}{10}$ in. (2·54 mm.)	$\frac{3}{10}$ in., or rather less (about 7 mm.), had been $\frac{2}{10}$ in. on May 13th.

No difference is perceptible, by the thermometer, in the temperature of both sides. The bowels are still very costive.

The patient continued, according to Mr. Stuckey's report, to improve steadily, though slowly, in every respect, until about five weeks after the last report, when he was suddenly seized with rigors, followed by the symptoms of pleuro-pneumonia of the right side, and died eight days later before I had seen him again. The phenomena of the paralysis had not been perceptibly affected by the last illness.[1]

Post-mortem examination.—Thirty-four hours after death. Cadaveric rigidity on both sides slight. The muscles of the limbs of the right side thinner than those of the left; no marked difference between both sides of the trunk.

The abdominal organs offer nothing abnormal.

The right lung is adherent by fresh layers of lymph, and there is about half a pint of sero-purulent effusion in the right pleural cavity; the greater portion of the same lung exhibits the phenomena of recent broncho-pneumonia. The upper lobe of the left lung is normal, the lower lobe is congested, and a small portion of it shows likewise traces of broncho-pneumonia. The left ventricle of the heart is much hypertrophied; the aortic valves are considerably thickened and rigid (stenosis and insufficient closure); the lining membrane of the aorta contains many atheromatous spots; the anonymous trunk, carotid, subclavia, and aorta descendens are felt on several spots thickened and rigid.

The cranium, dura mater, and arachnoid membrane

[1] It ought to be mentioned, that the patient had been in the habit of riding in an open carriage during the last eight or ten days before the appearance of the inflammatory chest symptoms, and that the latter first manifested themselves three days after a long drive, when the patient had felt chilly.

are normal. The subarachnoid serosity is slightly increased in quantity, it occupies the intergyral spaces, and scarcely raises the arachnoid from the surface of the convolution; it is almost equally distributed over the convex surface of the hemispheres and over the base, and is quite transparent. The pia mater contains a moderate quantity of the just described fluid in its meshes, and is everywhere easily separable from the brain without any loss of substance. The sinuses of the dura mater contain a moderate amount of slightly coagulated blood.

In examining the base of the brain, the basilar artery is found to be rather rigid, and to contain several atheromatous spots; and a similar condition is met with in the cerebral portions of the internal carotid, and also in the middle and posterior cerebral arteries of the left side. The substance of the hemispheres, and of their ganglia and commissures, the ventricles, and their contents, offer nothing abnormal.

The left crus cerebri looks very slightly fuller than the right, the colour being, however, scarcely different in both; the third nerve of the left side is just perceptibly pushed towards the right. In making a horizontal section through the centre of the lower part of the crus, an oblong clot of blood is discovered in its internal half, which clot is about 0·6 inch (15·0 mm.) long, about 0·25 inch (6·3 mm.) broad, and almost as deep; it is situated very close to the internal and inferior surface, being separated from it by only a thin layer of nerve-substance; its commencement is immediately in front of the pons. (The accompanying sketch shows the situation and outlines of the clot.) The blood is of dark colour and rather dry, *i. e.*, less fluid and soft than a newly formed clot. The surrounding tissue is tinged yellow to the depth of about $\frac{1}{14}$ inch (1·8 mm.), and more tense than the remainder of the substance of the crus. No membrane can be recognised round the clot. To the naked eye there is no difference in the appearance of the third nerves of the two sides. Both optic nerves look quite natural.

The microscopic examination of the clot manifests many shrivelled blood-globules, besides many apparently unaltered ones. The surrounding yellowish and tense tissue contains scarcely any nerve-fibres, but much connective tissue. In the left third nerve many oil-globules, and granules of various size, and also small granular corpuscles, are found, which are absent in the right nerve; the nerve-fibres in the left nerve are scanty and broken down. No difference is found in the microscopic appearance of the optic nerves of both sides.

The cerebellum, the corpora quadrigemina, the pons and medulla oblongata, offer nothing abnormal.

With regard to the Diagnosis, this case belongs to the rarer class of cerebral affections, in which an almost accurate diagnosis is comparatively easy. Sudden paralysis of the right side of the body, with immunity of the mental faculties and special senses, and paralysis of the third nerve of the left side, were the prominent facts, pointing unmistakably to an affection near the base of the left hemisphere and near the origin of the third nerve. The fact that none of the other cerebral nerves of the same side was affected, demonstrated that the morbid condition was confined to a small spot. I thought at first of an aneurism close to the inner side of the left crus, but the circumstance that the paralysis of the right side was so complete, soon rendered it more probable that some hæmorrhage or other morbid process had taken place within the substance of the crus cerebri; and the bursting of a blood-vessel externally to the crus appeared still more unlikely by the consideration that it would most likely have caused a more extended injury to the nerves situated at the base of the brain. The existence, however, of the aortic disease, and of the rigidity of other arteries, recognised during life, rendered the disease of the cerebral arteries, and therefore that of hæmorrhage, more likely than that of other cerebral affections.

Such accuracy of diagnosis in cerebral diseases is, however, unfortunately but seldom obtainable, and almost only in morbid conditions situated near the base of the brain, where they interfere not only with the conducting or transmitting function of the large tracts of nerve-fibres contained

within the medulla oblongata and its cerebral expansion, but also with that of the cranial nerves issuing from the base of the brain, and thus cause what the French call, I believe, "*paralysie alterne*," i.e., paralysis of one side of the body (side opposite to the lesion), and of one or several cranial nerves on the other side (side of the lesion). Griesinger's remarks on the diagnosis of cerebral diseases contain much valuable information on this point.[1]

With regard to the pathology of the crura cerebri the case before us is especially valuable, because the alteration is of limited circumference, and is uncomplicated with any other morbid condition of the brain. In considering the principal symptoms we must bear in mind that the clot occupied a great portion of the internal and inferior part of the left crus, and thus paralysed its function, while the external and upper part appeared unaltered. The symptoms in question were: Total immunity of the intellectual faculties, with the exception of the first moments after the seizure, when the transitory loss of consciousness was, no doubt, due to the general shock, and not to the local affection; almost total paralysis of the limbs of the opposite side as to motion, and considerable impairment as to sensation; imperfect, and less persistent paralysis of the muscles of the trunk and of the fifth, of the pars dura of the seventh, and of the ninth cerebral nerves of the same side; the affection of the pneumogastric nerve manifested itself in the more than usually slow and irregular action of the heart during the first days after the seizure; to the impaired action of the same nerve, combined with that of the sympathetic, I am inclined to ascribe also the production of, or at all events the disposition to the broncho-pneumonia, and pleuritis appearing two months after the hæmorrhage, the more so, as the right side was the one principally attacked; the participation of the sympathetic nerve was further manifested by the increased temperature of the paralysed side. On the side of the lesion we have the paralysis of the third nerve, causing, in

[1] "Diagnostische Bemerkungen über Hirnkrankheiten," in 'Archiv für Heilkunde,' vol. i, 1860, p. 51.

addition to the strabismus, some interesting phenomena of vision which I shall not endeavour to analyse at present; there was, besides, an occasional pain in the temple, but this was but moderate, and appeared only after the first week.

In searching for instances of disease of the crura cerebri published by others, I have met only with few uncomplicated cases, although I will by no means assert by this that our literature does not contain others besides.[1]

A very important case is furnished by Andral in his 'Clinique Médicale' (Third edition, vol. v, p. 339, 1834).

"A woman, about 60 years of age, came into the 'Hôpital de la Pitié' in March, 1831, with symptoms of chronic peritonitis. She had, besides, hemiplegia of the right side, of four years' standing; the voluntary movement of that side being entirely destroyed, and the sensibility very obtuse. She said that one morning in waking, she found herself thus paralysed, after having been quite well on the previous evening. The face had been unsymmetrical in the beginning. She had no head symptoms either before or after the attack; voice, intelligence, and special senses were normal. Death occurred from peritonitis. The post-mortem examination exhibited a cavity of the size of a cherry, rather oval, filled with a greenish serous fluid, in the middle portion of the left crus cerebri; the cavity was lined with a tense membrane, and surrounded by hard tissue some lines in thickness. The rest of the brain was normal." There were also evidences of chronic peritonitis, and there was sero-purulent effusion in the right pleural cavity. Andral remarks upon the rare occurrence of such lesions, and the fact that symptoms were restricted to paralysis of motion and sensation in the limbs of the opposite side.

[1] In the excellent dissertation of Werner Nasse, "De singularum cerebri partium functionibus ex morborum perscrutatione indagatis" (Bonnæ, MDCCCXLV), I find, in addition to Andral's and Green's cases, two others mentioned; one by Mohr (Casper's Wochenschrift, 1840), the other by Duplay (Archives gén. de Méd., Nov., 1834); but in both cases the lesions were extensive and complicated, and the symptoms not well defined.

The great similarity between Andral's case and the one just related to the Society is self-evident. The absence of the paralysis of the third nerve on the side of the lesion is very natural, as the lesion existed in the centre of the crus, and not near the origin of the third nerve.

In a paper on 'Tubercles of the Brain in Children,' by Dr. P. Hennis Green, published in vol. xxv of the 'Medico-Chirurgical Transactions,' I find the following notes at page 195, under No. 7:

"Le Platu, girl, æt. 3½. Symptoms of two months' duration; headache; stupidity; paralysis of left side; strabismus; constipation; somnolence; lesions: tubercle in the right crus cerebri, with green detritus around; tubercles in chest and abdomen."

The shortness of these notes prevents us from interpreting with certainty the phenomena related in them, but it appears probable that "the paralysis of the opposite side, the strabismus, the constipation, and perhaps the headache," were due to the affection of the crus cerebri, while the "stupidity and the somnolence" may have depended on complications which are so frequent in tubercular affections of children; as, for instance, tubercular meningitis.

Very different from the symptoms observed in these cases of disease in man, are those described as the results of experiments on animals (cats, rabbits, and dogs). Magendie, Lafargue, Longet, Schiff, and others have all found that section of either of the crura cerebri causes the animals to perform circus movements ("mouvements circulaires ou de manège"), although the different observers do not quite agree with regard to the direction of these movements, and the interpretation of the phenomenon. Schiff, who is one of the latest authors on the subject, states that, if the section of the crus cerebri is complete, the circuit is narrow, and the circus movement is persistent, *i. e.*, it can still be witnessed in the second week after the operation, while, if the section is only partial, the circuit performed by the animal is larger, and the animal after a short time again becomes enabled to walk in a straight line ('Lehrbuch der Physiologie des Menschen,' von J. F. Schiff, vol. i, p. 343, 1859). The same observer asserts that the section of the crus does not cause any hemiplegia whatever, but that the head and neck turn towards the side opposite to the lesion, as soon as the animal endeavours to move; while when at rest, the head is kept in the middle line, and both forelegs are directed towards the side of the section if the animal attempts to stand on them or to move. To this peculiar direction of the neck and forelegs, Schiff ascribes the occurrence of the circus movements in animals; and if this explanation be correct, the absence of real circus movements in man would be explained by it, as we do not use our arms for walking

Longet and Lafargue likewise assume that the circus movement takes place in the direction opposite to the lesion, but they explain it by assuming imperfect paralysis of the limbs of the opposite side as the cause of it. (Traité de Physiologie, par F. A. Longet, seconde édition, vol. ii, p. 409, 1860.)

With regard to sensibility, Schiff remarks that, in rabbits and cats after the section of the crus cerebri, the head and the extremities of the side of the lesion are much more sensitive than the same parts on the opposite half of the body, and that this greater sensibility does not depend on anæsthesia of the latter, but on hyperæsthesia of the former.

How can we explain, we naturally ask, these differences between the pathological phenomena in man, and the experimental phenomena in animals? It would lead too far to discuss here this often discussed subject. We may say that the pathological lesions in man, and the experimental lesions in animals, are not quite the same; and further that the anatomical and functional relations of the different parts of the brain in man, and in the animals experimented upon, are likewise different; but we certainly ought not to throw away the results of vivisections, when they do not agree with our pathological observations; we ought, on the contrary, to be prevented by them from making premature inferences, and to

be led to further and more careful observations. If this remark is correct with regard to other portions of the brain, it is also most certainly so with regard to the crura cerebri, concerning which our pathological experience is so limited.

It would, however, if we might judge from the cases described, seem probable, but not certain, that any considerable lesion of the centre, the internal and lower portions of the crus cerebri in man (the only parts which were diseased in the three cases mentioned), causes:

1. Almost perfect paralysis of the limbs of the opposite side as to motion, and great impairment as to sensation; 2. Less complete, and only transitory paralysis of the opposite side of the face, leaving, however, the muscles of the eye intact; 3. A similar, but perhaps more permanent impairment of the pneumogastric and sympathetic nerves of the opposite side; 4. A great retardation in the functions of the intestinal canal. 5. The intellectual faculties, and the spinal nerves seem to be altogether independent of the crura cerebri. 6. The third nerve on the side of the lesion (not on the opposite side) seems to become paralysed only in those morbid conditions of the crus which affect the most internal and inferior layers of nerve-substance, close to the place of issue of the said nerve.

With regard to diagnosis, paralysis of the limbs and body of one side, with paralysis of the third nerve of the opposite side, and with immunity of the other cranial nerves of the latter side, and of the intellectual faculties, and spinal senses, may be regarded, with a considerable degree of probability, as pointing to an affection of the inferior and internal part of the crus cerebri, close to the pons, situated on the side of the paralysed third nerve.

Respecting the prognosis, Andral's case, and the one related by myself, show that hæmorrhage into the crus cerebri is not necessarily fatal; but both cases demonstrate also the applicability of the old axiom, that organs entirely or only partially deprived of their normal nervous influence, are more liable to inflammation, and they teach us also that through this liability new dangers in distant organs arise in cerebral affections, and in diseases of the nervous centres in general. I can scarcely resist finding an intimate connection between the hæmorrhage into the left crus cerebri, and the right-sided broncho-pneumonia and pleuritis, which killed our patient two months after the occurrence of the hæmorrhage, when he was already on the road to convalescence. As to Andral's case, it may perhaps appear rather farfetched if I connect the hæmorrhage into the left crus, and the sero-purulent effusion into the right pleural cavity, and the chronic peritonitis with sero-purulent effusion,[1] met with four years after the hæmorrhage; but the facts that the pleuritic effusion occupied the right side, and the consideration that idiopathic peritonitis is on the whole of rare occurrence, strengthen the opinion that the old cerebral lèsion exercised some influence in the origin of these morbid conditions.

This liability to diseases of remote organs ought also to be taken into consideration in the treatment of such cases, by showing us the necessity of avoiding all agencies likely to cause congestion or inflammation of any part of the body. The cerebral affection itself is not amenable to our treatment, which must regard the general health, and the concomitant circumstances of the patient, and will in most cases mainly consist in proper nursing as to rest and diet.

I was on the point of sending my paper to the Society, when I received, through the kindness of the author, the inaugural dissertation of Dr. F. J. Stiebel, of Frankfort, describing a remarkable case of disease of the crus cerebri.[2]

[1] Andral's own words concerning the post-mortem examination of the thorax and abdomen are:

"*Thorax.*—Poumons sains. Epanchement séro-purulent dans la plèvre droite. Coeur normal.

"*Abdomen.*—Liquide séro-purulent dans la cavité péritonéale. Adhérences des anses intestinales par des brides celluleuses encore molles. Pâleur de la surface interne du tube digestif (loc. cit., p. 340)."

[2] Paralyseos hæmorrhagicæ nervi oculomotorii in infante observatus casus rarissimus, Dissert. inaug. medica, quam in Universitate Ruperto-Carolina submittit, F. J. Stiebel, M.D., Francofurti ad Moenam, MDCCCXLVII.

As this dissertation is very little known, I do not hesitate in annexing a description of the case in question.

A girl, æt. 11, habitually subject to attacks of bronchial catarrh, dyspnœa and disturbance of circulation, had suffered in March, 1847, from periodic earache ("otalgia periodica"), but had been cured of it by quinine, and had been comparatively well, when, a few days after exposure to great heat in the sun, she was suddenly, on June 21st, attacked with headache, which disappeared on the following day, leaving her "pale and weak on her legs;" on June 23rd, headache, nausea, slight swelling of the face, pulse 140, very weak, consciousness unaffected; on 24th only moderate headache; on 25th, in addition to violent pain in the left part of the forehead, ptosis of the left upper eyelid, hanging of the left angle of the mouth, dilated left pupil, and photophobia, with undisturbed vision, weak and frequent pulse, nocturnal delirium, absence of paralysis in the extremities; on 26th, headache diminished; ptosis and dilatation of the pupil continue, but angle of mouth not any longer hanging; head always turned to the right; on the 28th, increased headache; towards evening rigors; on 29th, some degree of anæsthesia in the left side of the face, with continued headache, principally in the left supra-orbital region; weakness and frequency of pulse, and costiveness as before; the left upper eyelid is constantly rubbed with the back of the left hand; on June 30th, trismus, and tetanic convulsions of the limbs; death two hours after the accession of these symptoms.

Post-mortem examination.—Brain rather large; on its base, in front of the left side of the anterior margin of the pons, the colour is changed on a small spot from which pus oozes out. The removal of the pia mater, which is otherwise healthy, shows the left crus cerebri just in front of the pons much enlarged and softened; the diameter of the right crus being six, that of the left thirteen lines. The posterior part of the left optic nerve slightly softened and enlarged. In the left crus cerebri is seen an oblong aperture of an abscess or ulcer ("ulcus") which contains good-looking pus, mixed with grayish-white fibres of softened brain-substance. In its posterior part, near the pons, the ulcer is perfectly circumscribed, while in front it enters a little into the substance of the crus. The third nerve issues about a line distant from the interior margin of the "ulcer," and about five lines more in front than the right third nerve, the structure of the nerve itself being unchanged. The dilatation of the aperture of the "ulcus" shows that its length from the pons anteriorly is nineteen lines, and its greatest breadth fourteen lines. In that part of the "ulcus" which is nearest to the pons, a "focus hæmorrhagicus" is found, about nine lines great ("magnitudine novem linearum"), well circumscribed, grumous, and enclosing a drop of pus. The substance forming the ground floor of this focus is red, and covered with a few red granulations.

The rest of the brain with its ventricles is normal. The organs of the chest and abdomen contain nothing abnormal, with the exception of the heart, which is in the state of concentric hypertrophy.

It is to be regretted that in the description of this most interesting case neither the depth of the "ulcus" or abscess is mentioned, nor the general and microscopic appearance of the remaining substance of the crus. The circumstance, however, that the diameter of the diseased crus was more than twice as large as that of the other side, renders it probable that its structure had been altered, at least for the time, in a great part. This case would, therefore, teach us that a rather considerable portion of the lower part of the crus cerebri may be altered in substance without causing hemiplegia of the opposite side; a fact for which we had been scarcely prepared after having met only with the three cases described in the former part of this paper. The lesion in Stiebel's case does not, it is true, occupy quite the same spot as in the other cases, and the destruction of tissue may have been rather superficial, but the alteration of tissue at the time of death must have been, to judge from the swelling of the crus, much more extensive.

I will not attempt farther to analyse the case, as I have

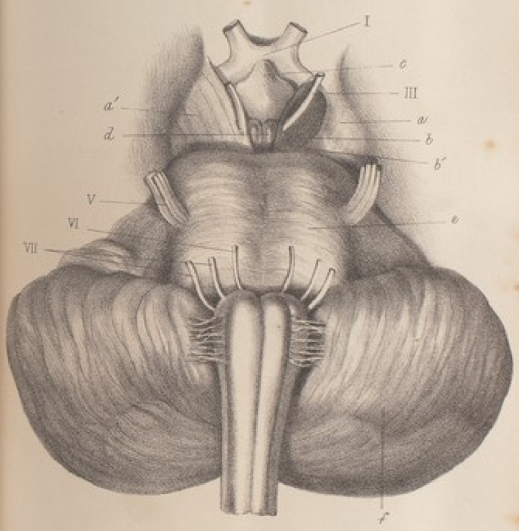
occupied the time of the Society too long already; I may, however, draw attention to the symptom mentioned in Stiebel's case, that the head was always turned to the right, *i. e.*, the side opposite to the lesion—a fact which coincides with the results of vivisections, and which had not been remarked in any of the other cases. I further cannot help pointing out how Dr. Stiebel's case demonstrates the necessity of our guarding ourselves against hasty inferences from a few pathological observations, especially in cerebral affections. Our duty in such cases is carefully to note the symptoms manifested during life, accurately to describe the anatomical lesions found after death, and to compare our pathological experience with the teachings of anatomy and physiology of man and animals. In this manner we may hope to obtain, sooner or later, some insight into the functions of the different parts of the brain, and to learn at the same time to distinguish the real from the apparent symptoms of their lesions.

DESCRIPTION OF PLATE VI.

The crura cerebri and pons varolii, showing the seat of the hæmorrhage in the left crus, in Dr. Hermann Weber's case.

a. Left crus cerebri.
a'. Right crus cerebri.
b. The dark spot showing the outline of the hæmorrhage.
b'. The margin surrounding the dark spot indicating the indurated tissue round the blood clot.
c. The pituitary gland.
d. The corpora albicantia.
e. The pons.
f. The cerebellum.

I. The commissure of the optic nerves.
III. The third nerve.
V. The fifth nerve.
VI. The sixth nerve.
VII. The *pars dura* and *pars mollis* of the seventh nerve.



G.H.F.

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NOTICE

ON THE LAW OF THE

PRODUCTION OF SEXES

IN

PLANTS, ANIMALS, AND MEN.

BY

MARC THURY,

Professor of the Academy of Geneva.

MDCCCLXIII.

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INTRODUCTION.

THE question that is solved in this notice has been at all times a subject of investigation, yet it has hitherto remained unresolved. Thus it came to be the general belief that man was utterly powerless as regards the mysterious phenomenon of the production of sexes, and that any farther investigation would prove as useless as the former ones.

Still where there is no *a priori* impossibility, the fruitlessness of previous exertions is no evidence of the unavailableness of subsequent exertions. Owing to the continuous progress of science, many things may prove comparatively easy, that formerly were beyond the power of human minds.

If to this is objected the providential order that rules all created things and beings, which order is immutable, and should not, with propriety, be considered as likely to be disturbed by man, my answer will be as follows:—Nature's fundamental order is indeed immutable, but we should not take for such our more or less imperfect notions of the laws of Nature. I believe an apparent perturbation to characterise the passage in the real order from an inferior conception to a superior one.

The law of sexes, when applied to the animal kingdom, is productive of some practical effects which may be at once pointed out. Cattle breeders are enabled henceforward to obtain, according to their wishes, male or female animals. Now it is very seldom that it is the same for a cattle breeder to obtain a male or female animal. In each particular case, the advantage of obtaining the one rather than the other is tantamount to a certain sum of money. This is not the first instance of a purely scientific discovery becoming the means of an increase in the wealth of the community.

The author of the present discovery, the accuracy of which two years' experiments have already demonstrated, now offers it to be tried by the public at large.

This course of proceeding he looks upon as being the most safe, and such as to shield the public from any deceit.

LAW OF SEXES.—DEDUCTION.

Professor Lindley, in his book on the Theory of Horticulture, points out that, according to Knight's experiments, heat is favourable to the production of male flowers in diœcious plants, such as water melons and cucumbers.

I had long looked upon that fact as well worth being attended to, and, by considering its meaning in connection with General Physiology, I came to the following conclusions :—

Heat operates mediately on plants, by bringing on a more complete elaboration of the juices, and therefore a more thorough maturation of the organs. Thus the production of the male element answers to a more thorough maturation, otherwise to a more complete development of the organs. Such I deemed likely to be the meaning of Knight's experiments.

To enable us to apply to the animal kingdom those notions that originate in the vegetable one, we must compare the sexual marks and manifestations in both kingdoms. Most of the diœcious plants, at any rate those plants Knight experimented upon, are hermaphrodite, and become, as every botanist is aware, *diœcious* through abortion. Comparative anatomy of the male panicle and of the female ear in maize, which was one of my earliest botanical works, had long made me alive to the fact I have just mentioned. I felt fully satisfied that both the panicle and the ear in maize are constructed according to one single type, and that they show a like disposition in their organs, which differ only in the stage and mode of their growth and development. Most of the pistils of flowers in the panicle remain in a rudimental condition, as do the stamens of the flowers in the ear. As regards general growth, the male panicle expands rather in length, and the female ear rather in breadth; the panicle spreads, while the ear wraps itself in.

Thus, in many plants, diclinism is in some way accidental, and not, as it is in animals, deep seated and original. It is, therefore, much easier to study in plants than it is to study in animals those peculiar circumstances owing to which the male or the female element developes itself. Both elements in plants being, at first, nearly equal in power and as well balanced, small forces, easily mastered by the experimentalist, will be enough to turn the scale on either side, that is to bring forth one sex or the other.

What we have now to consider is, whether the forces that cause the development to take place, at a time when the sexes are already virtually determined, may be assimilated to those by which the original formation of sexes is governed. That assimilation would be looked upon as a probable fact, provided the fundamental identity of both sexes had been previously proved. Then would it not be unnaturally admitted that the force which, when at first operating on a neutral matter, determines the one sex or the other, is the very same force which by the protraction of its action evolves and completes whatever sex it has brought out. Thus to know the latter force would be knowing the former one. At any rate, before we look upon these forces as distinct, we had better ascertain that they are not to be considered as one. Natural philosophy objects to forces being uselessly multiplied.

In plants, the fundamental identity of stamens and of pistils is admitted by all botanists, who, with G. F. Wolff, Goethe, De Candolle, and Robert Brown, consider stamens and pistils as modified leaves The inference to be drawn is the same, if believing with many a contemporary botanist, that an element belonging to the stem adds itself to that of the leaf, in order to form the pistil; that this is not connected with the fact of the pistil being a female organ, appears clearly through the accidental transformation of poppy stamens into well formed pistils.

Some anatomical investigations which in former years I undertook with Professor Hollard, made me positively convinced, that, in the animal kingdom, both male and female sexual apparatus are constructed upon one single plan, or according to one and the same type, which fact bears witness to their original identity and enables us to explain the characteristic discrepancies between both sexes, by mere harmonic discrepancies in the mode and quantity of the growth.

The probable determining causes of these harmonic discrepancies, are, according to Knight's experiments, to be looked for, in plants, amongst the causes that beget a more complete maturation of the organs. Now as sexual life belongs in common to animals and to plants, being, no doubt, in both kingdoms governed by fundamental laws that are materially identical, therefore the determining causes of sexual discrepancies in animals, will be those very causes that lead to a more complete maturation of the organs.

Thus there is a time in the animal's dark life, when the fact of a more complete development or a more finished maturation bears in favour of the male sex. The *secondary* determination of the sex may possibly take place, but at a late period in plants; still in both kingdoms the original determination is concealed in the dimness of original preformations.

In mankind the sex may be distinguished in the course of the second month following impregnation. Thus, in mankind, the moment at which the selection of the sex is made cannot but be included between the first development of the egg and the second month following impregnation; whether however it precedes, follows, or is concomitant with impregnation, remains uncertain.

First, in order to know whether it precedes impregnation, the easiest plan would be to select the eggs of

some oviparous animal, and then, other things being the same, the most complete development being found in the maturest eggs, to set apart the eggs according to their several ages, after which to fecundate them artificially, so as to see whether the oldest eggs will yield males. Perhaps a still easier experiment would be sufficient, viz., to observe in animals in which the eggs are fecundated on their way after having left the ovaries, whether males are yielded by the last eggs in each particular laying, which eggs are likely to have had most time to mature.

Now such an observation has long ago been made by Huber. This eminent naturalist discovered that in bees, fecundation, when taking place early, generates females, whilst if later it always produces males. I had also some ground to believe, that in poultry, the cocks of the brood are from the last-laid eggs.

From the lack of time and of any proper accommodation, I had it not in my power to proceed with the like experiments on other animals. I therefore determined on attempting a decisive trial upon mammifers. It was my good fortune to find in the well famed farm of Montet, by the active and skilful co-operation of its manager, M. George Cornaz, the best conditions for success that I could possibly expect to meet with.

It is a well known fact, that mammalian ova get loose from the ovary at the beginning of the rut, and that they are in a condition to be fecundated as long as the period of heat lasts, that is, therefore, even when they have reached a comparatively mature point. Truly that period is short, but during the first stages of *genetic development*, when all the essential elements of the coming being are as yet undeveloped, the creative power is actively at work, and capital alterations follow each other in a very short time.

I therefore directed M. Cornaz to get his cows served in the beginning of the rut, in order to procure females, and at the end of the rut, to procure males. The result was such as I had foreseen. (See M. Cornaz's Notice.)

I may add that when the exact experiments recorded in the Notice were over, M. Cornaz, being desirous of obtaining chiefly heifers, merely directed his men to get the cows served in general at the first indications of heat in the animals. This direction was given by the way and as if little cared for, so as to avoid rousing the servants' attention. Nevertheless it did not fail to procure for M. Cornaz a far larger amount of females than of males.

The whole duration of the descent of the ovum into the fallopian tubes and uterus (from twenty-four to forty-eight hours with cows) is divided into two equal periods. If fecundated in the first period, the germ turns out a female ovum; if fecundated in the second period, the germ is a male ovum. The moment that severs the one period from the other, I will call the turning point (*moment de vire*).

The experiments at Montet had in view the verifying of the chief fact itself, together with its constancy in highly favourable circumstances No endeavour was made towards investigating the comparative duration of the two periods in the uterine existence of the ovum;

and those either external or organic circumstances by which that duration may be modified, were left unstudied. Perhaps it varies a good deal; perhaps in some females the genital apparatus may be so weak, that the egg cannot reach the second period of its normal development. Such females in such a condition would beget only females. With an opposite disposition, the female period in the egg would be shortened, and male conceptions more likely to occur. Facts of a similar description have been observed in the human species, but I know not whether they occur in the animal kingdom. Moreover, it is likely that the male's influence may alter the comparative duration of both periods, by modifying the female's organic state.

New observations will, some time or other, teach us what notions we are to entertain as regards the organic alterations that occur in the ovum within the uterine period, that is during the passing of the ovum through the fallopian tubes and the uterus. Those alterations with which an increase in the size of the ovum is concomitant, will be more carefully studied, when it is known what physiological points they are connected with.

It is only in the germ that any development, any evolution, if there be any, takes place. All such intermediate gradations between the two sexes, as might be conceived, cannot be realised in the actually existing being which is wholly male or female. Either fecundation ceases to be possible during the intermediate period, or, more probably, the regular progress of the maturation of the ovum brings about at a given time a sudden alteration, such for instance as occurs at the bursting of the germinal vesicule. In consequence of that sudden crisis, the germ hitherto a female ovum becomes a male one.

Let us besides bear in mind, that the modifications of the ovum are merely histological and chemical, and that they have no conformity whatever with those future organic conditions to which they are preparatory, or to bring about which they are requisite.

In the main, between two different harmonic systems there exists no harmonic transition. The transition would be the deformed being, the monster which nature in her regular course does not realise, and which she is enabled to avoid without snapping the bond of the regular succession of beings by means of the *critical* development. The moment of the crisis when the transition is hurried, is for the most part concealed in the utter darkness of the germ's life.

Thus, geological species have succeeded each other. Nature hurries on her destiny. She does not drag in those accumulations of endless periods and of shapeless productions which are often ascribed to her.

In the general meaning it conveys, the law of *critical* development is everywhere recorded, in nature and in history, and expresses itself by hope and by grief, by renewal and by death.

SUMMARY & PRACTICAL OBSERVATIONS.

First.—The sex depends upon the stage of maturation in the ovum at the time it is fecundated.

Second.—If the ovum has not reached a certain stage of maturation, then, if fecundated, it yields a female; if it has passed that stage, then, if fecundated, it yields a male.

Third.—When at the period of heat a single ovum gets loose from the ovary, slowly to descend into the genital tube, (uniparous animals,) it is enough that fecundation should take place at the beginning of the rut, in order to procure females, and at the end in order to procure males, as the turning point of the ovum regularly occurs during its course through the genital tube.

Fourth.—When several ova in succession get loose from the ovary during the same generative period, (multiparous and most oviparous animals,) then the first eggs are generally less developed and yield females; the last ones are more mature and yield males (bees, cocks). But if it so happens that a second generative period should succeed the first one, or that the external circumstances should be entirely altered, (as in *aphides*, during winter,) then it may be that the last eggs do not reach the higher stage of maturation and still yield females.

Other things being the same, the principle of sexuality is not so easily to be applied with multiparous as with uniparous animals.

Fifth.—In order to apply the above principles to the large mammifers, the experimentalist must notice first the course of the rut-appearances in the animal on which he intends to operate, so that he may be exactly aware of the rut's duration and indications, which not unfrequently vary in different animals.

Sixth.—It is obvious that no positive result can be expected when the indications of heat are uncertain or ambiguous. This is seldom the case with animals that are let free, but may happen with fattening or stabled cattle.

Seventh.—From the way in which the law that rules the production of sexes has been deduced, it follows that such a law is general and should be applicable to all organised beings, that is, to plants, to animals, and to mankind.*

We are carefully to distinguish the law itself, (Nos. 1 and 2 of the present summary,) which is absolute, from its more or less easy applications.

NOTICE BY M. GEORGE CORNAZ.

I, the undersigned, George Cornaz, manager to my late father, the President of the Suisse Romande Agricultural Society, M. A. Cornaz's estate, at Montet, Canton of Vaud, Switzerland, hereby testify to having, on the 18th of February 1861, received from Professor Thury of Geneva, confidential instructions, the object of which was experimentally to test the law by which the production of sexes in animals is ruled.

I availed myself, upon my herd, of cows of such information as M. Thury had imparted to me, and *I have at once and without the least difficulty obtained all the expected results.*

* The time for the descent of the ovum, which time in women corresponds to the rut in animals, includes the first ten or twelve days following the menstrual periods. The duration of that period is rather variable.

In the first place, in twenty-two successive cases, I tried to procure heifers; my cows were of Schwytz breed and my bull a thorough-bred Durham: the breeders had heifers in request, whilst males did not sell excepting to butchers: *in every single case* I obtained the wished for result.

Having at a later period bought a thorough-bred Durham cow, it was of importance to me to obtain a new bull which should succeed the one I had paid very highly for, and without merely waiting for the chances of a male offspring.

I operated according to Professor Thury's instructions, and the event once more confirmed the truth of the process imparted to me. That process can be at once and very easily applied.

Besides obtaining my Durham bull, I obtained six other bulls, crossed Durham-Schwytzes, which I intended for working purposes. By selecting cows of the same coat and size, I procured well matched pairs of oxen. My herd contains forty cows of every age.

To sum up, I have made in all twenty-nine experiments conformably to the new process: in not one single case has it failed. The whole of the experiments have been made by myself, without any body interfering.

Pursuant to which I can declare, that I look upon Professor Thury's system as true and perfectly safe, and I trust that he will soon enable all cattle breeders and farmers to take advantage of a discovery which will regenerate the business of cattle breeding.

Made at Montet, the 10th of February, 1863.

(Signed) G. CORNAZ.

PRACTICAL INSTRUCTIONS,

To obtain at will, animals belonging to the one or to the other sex, in cattle of the bovine race.

First.—The course, character, indications, and duration of rut-appearances should be previously observed in the cow upon which it is proposed to experiment, as they vary a little according to each animal. It is a well known fact, for instance, that the duration of the rut varies in different cows from twenty-four to forty-eight and even a greater number of hours.

Second.—When, according to instruction No. 1, the experimenter knows well the cow he intends to experiment upon, he is to operate as follows :—

To procure an heifer, have the cow served at the first indications of rut.

To procure a bull, have the cow served at the end of rut time.

Third.—Those animals in which the indications of rut are loose and uncertain, as is frequently the case with fattened or shut-up cows, should be excluded from the trial. Animals living in the open air should be selected in preference. Sound animals and such as are in regular conditions should be chosen.

Fourth.—The same experiments may be tried upon horses, asses, sheep, goats, etc. Although hitherto untested as regards those animals, our theory promises with them the same results as have been obtained with cows.

(Signed) M. THURY.

ON

THE PHENOMENA

OF

DIABETES MELLITUS.

BY

REV. SAMUEL HAUGHTON, M.D., F.R.S.,

FELLOW OF TRINITY COLLEGE, DUBLIN.

[From the Dublin Quarterly Journal of Medical Science, February, 1863.]

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1863.

ON

THE PHENOMENA

OF

DIABETES MELLITUS.

PART II.

(*Continued from* Vol. xxxii., p. 277.)

IN the former part of this paper[a] I gave an account of three cases of diabetes mellitus, in which I attempted to ascertain the excretion, both of sugar and of urea, and from which I deduced certain conclusions, to which, of course, the same value cannot be attached as to the observations themselves.

I shall now add three more cases of this disease, from which the same general conclusions may be inferred:—

For the clinical observations on these cases I am indebted to A. W. Foot, M.B.; and to Doctors Stokes and Hudson, Physicians to the Meath Hospital, for permission to make my observations, and for many valuable suggestions during their progress. I made, myself, all the determinations of sugar and urea in the laboratory of Trinity College.

CASE IV.—Thomas Cooke, aged 40, admitted into the Meath Hospital October 1st, 1861, under Dr. Hudson.

[a] D. Q. J. M. S., Vol. xxxi., p. 317, and Vol. xxxii., p. 265.

History of Case.—Is a labourer, and comes from Co. Leitrim; married, of temperate habits, and excellent previous health; no history of hereditary predisposition.

Jan. 1860.—"Got a cough;" spat blood; in latter end of July, 1861, cough returned, and he spat blood, and became affected with great thirst and diuresis; "at the commencement of this cold his urine was not clear;" but three weeks before admission he passed a quantity of urine, estimated at three quarts, clear and sweet (teste linguâ); the quantity of urine now voided is much less, and of deeper colour, "because he stints himself in drink."

Since July his appetite has been bad, his strength and flesh rapidly diminishing.

Condition on Admission.—Passing saccharine urine, sp. gr. 1042; no albumen; of clear gold colour; thirst excessive.

Heart.—Situation, impulse, sounds, normal; pulse, 91, regular.

Lungs.—Percussion clear, before and behind, over each lung; and respiration healthy, except under right sterno-clavicular articulation, where it is rougher than natural; bowels habitually costive; tongue dry, red at tip and sides; posteriorly and in centre a dry brown fur; sordes collect on teeth and lips; "bad taste in mouth continually;" gums spongy and bleeding; appetite bad; skin generally dry, but perspires occasionally; peculiarly greasy between shoulders, and on back generally; has remarked so himself; sleeps well.

Clinical Observations.—On the 8th of October it was discovered that there was fluid effused in the cavity of the peritoneum; the superficial epigastric veins on each side were enlarged and prominent; defecation was attended with pain in the lumbar region, and retraction of the testicles, and the spleen was found to be enlarged; the veins of the left leg and thigh were varicose; copious perspiration comes on while he is straining at stool.

October 9th.—Œdema appeared in both legs, but subsided in a few days; reappeared in right leg on 31st.

November 2nd.—He showed an anthrax forming on outside of right thigh, which, on the 5th, was opened by crucial incision down to the fascia, and bled freely; diarrhea began at this time, and appetite commenced to fail.

November 12th.—Retention of urine required use of catheter, and about 30 oz. were drawn off from the bladder; this operation

was performed also on 13th, 14th, and 15th; the effusion into the peritoneum became increased.

November 18th.—Diarrhea occurs every night; bowels moved every hour; can pass urine without catheter, but with much exertion; suffers much from pain in loins; the diarrhea was very rebellious to treatment; he was subject to occasional profuse perspirations, especially when at stool.

His appetite was very variable, but not at all excessive, nor by any means equal to the usual appetite of this disease. Sometimes he ate his allowance of bread, sometimes half of it, or none.

The following observations were made during his stay in hospital:—

(*a*) 2nd, 3rd October, 1861.—Weight (naked), 146 lbs.; passed 110 oz. fl. of urine, of sp. gr. = 1039·08; sugar = 4010 grs.; urea = 722 grs.

Previous Daily Food.

Bread, 8 oz., ...	134 grs. urea,	. 2377 grs. sugar.
Milk, 1 pt., ...	58 ,,	. 177 ,,
Tea, 1 pt., ...	5 ,,	. x ,,
Porter, 1 pt., ...	27 ,,	. 15 ,,
Oatmeal Broth, 1 qt.,	46 ,,	—
	270 grs. urea.	**2569** grs. sugar.

(*b*) 8th, 9th October.—Passed 70 oz. fl. of urine, of sp. gr. = 1042·78; sugar = 2553 grs.; urea = 674 grs.

Previous daily food same as before.

(*c*) 15th, 16th October.—Weight = 145 lbs.; passed 90 oz. fl. of urine, rancid in smell; sugar = 2461 grs.; urea = 709 grs.

Previous Daily Food.

Bread, 12 oz., . . .	200 grs. urea,	. 3566 grs. sugar.
Mutton, 8 oz., ...	368 ,,	—
Milk, 1 pt., ...	58 ,,	. 177 ,,
Tea, 1 pt., ...	5 ,,	. x ,,
Eggs, 2, ...	92 ,,	—
Porter, 1 pt., ...	27 ,,	. 15 ,,
Oatmeal Broth, 1 qt.,	46 ,,	—
	796 grs. urea.	**3758** grs. sugar.

(*d*) 23rd, 24th October.—Passed 64 oz. fl. of alkaline urine; sugar = 1666 grs.; urea = 896 grs. Previous food same as before.

(*e*) 29th, 30th October.—Weight = 145 lbs.; passed 68 oz. fl. of alkaline urine; sugar = 1750 grs.; urea = 714 grs.; phosphoric acid (combined with earths = 16·06 grs., with alkalies = 22·73 grs.); total = 38·79 grs. Previous food same as before.

(*f*) 5th, 6th November.—Passed 51 oz. fl.; sugar = 1115 grs.; urea = 558 grs. Appetite fallen off.

A large anthrax, which had formed on the back of the right thigh, was opened this morning (6th November), and bled freely; I took the opportunity to collect the blood for the purpose of examining it carefully for sugar. One ounce of this blood was evaporated to dryness at 212° F., reduced to powder, and percolated with alcohol (of sp. gr. 0·828), which did not dissolve the dextrine; I examined it for sugar with the cupro-potassic solution, and weighed the oxide of copper, which I found to be 0·95 grs.

As one ounce of sulphate of copper is used to make 12630 grs. of this solution, of which 1000 grs. are equivalent to 5 grs. of glucose; we readily find the following chain:—

1 oz. blood.
100 — 95 grs. oxide of copper.
40 — 125 grs. sulphate of copper.
7000 — 16 oz.
1 — 12630 grs. standard " solution.
1000 — 5 grs. glucose.

0·428 grs. glucose.

From this it is easy to calculate that there is 0·98 of a grain of glucose in every 1000 grs. of blood. At the time when the blood contained this quantity of sugar, 51 oz. fl. of urine contained 1115 grs. of sugar, or 21·863 grs. per ounce; dividing this by 0·428, the quantity of sugar in the ounce of blood, we find the fraction $\frac{1}{51}$th, to represent the dilution of sugar in the blood, as compared with that in the urine. I found, in the case of Owen Murphy, a theoretical dilution of $\frac{1}{52}$nd, from the measurement of the aorta and renal arteries; and it must be admitted that the present experiment falls in with the filter theory of the action of the kidneys.

(*g*) 13th, 14th November.—The catheter had to be used during the day; by means of it 40 oz. fl. were drawn off, which contained, sugar = 1000 grs.; urea = 682 grs. I obtained this day $1\frac{1}{4}$ oz. of blood by cupping, which I boiled and washed on a filter, with boiling water, passing the droppings into strong spirit, to coagulate the dextrine; this I afterwards collected on a weighed filter, and

found it to weigh 0·30 grains. From this it may be inferred that 1000 grs. of blood contained 0·548 of a grain of dextrine.

(*h*) 20th, 21st November.—Passed 40 oz. fl. of urine, sugar = 795 grs.; urea = 560 grs.

Shortly after this period Cooke left the hospital, at the desire of his friends, who wished him to settle his affairs, and returned to the country (Co. Leitrim); I have not been able to ascertain what became of him.

Mr. Foot has supplied me with the following table:—

Thomas Cooke.

	Urine		Weight (naked)
1861	Oz.	Sp. gr.	lbs.
Oct. 2, 3	110	—	146
" 13, 14	70	1040	—
" 14, 15	100	1039	—
" 15, 16	90	1042	145
" 16, 17	80	1045	—
" 17, 18	60	—	—
" 18, 19	80	1038	—
" 21, 22	75	1040	—
" 22, 23	68	—	143·5
" 23, 24	64	1045	—
" 24, 25	38	1045	—
" 25, 26	88	1040	—
" 27, 28	70	1047	—
" 28, 29	55	1045	—
" 29, 30	68	1045	145

Thomas Cooke—con.

	Urine		Weight (naked)
1861	Oz.	Sp. Gr.	lbs.
Oct. 30, 31	58	1043	—
Oct. 31, Nov. 1	95	—	—
Nov. 3, 4	80	1043	—
„ 4, 5	40	1045	—
„ 5, 6	51	1043	—
„ 6, 7	40	1045	—
„ 7, 8	58	1040	—
„ 11, 12	60	1040	—
„ 12, 13	30	1040	—
„ 13, 14	44	1043	—
„ 14, 15	48	1043	—
„ 17, 18	30	1042	—

Collecting together the preceding results, we obtain the following table:—

TABLE XIII.—*Case of Thomas Cooke.*

	Date, 1861	Weight	Urine	Sugar secreted	Sugar ingested	Urea excreted	Urea ingested
a	3rd Oct.	146 lbs.	110 oz. fl.	4010 grs.	2569 grs.	722 grs.	270 grs.
b	9th Oct.	—	70 oz. fl.	2553 grs.	2569 grs.	674 grs.	270 grs.
c	16th Oct.	145 lbs.	90 oz. fl.	2461 grs.	3758 grs.	709 grs.	796 grs.
d	24th Oct.	144 lbs.	64 oz. fl.	1666 grs.	3758 grs.	896 grs.	796 grs.
e	30th Oct.	145 lbs.	68 oz. fl.	1750 grs.	—	714 grs.	—
f	6th Nov.	—	51 oz. fl.	1115 grs.	—	558 grs.	—
g	14th Nov.	—	40 oz. fl.	1090 grs.	—	682 grs.	—
h	21st Nov.	—	40 oz. fl.	795 grs.	—	560 grs.	—

In the preceding table it is remarkable that the excretion of both sugar and urea, on Cooke's admission to hospital, was much in excess of the corresponding quantities ingested; showing that the change from his former diet to the hospital diet did not produce immediate effects. In all the experiments, except the first (*a*), the diet described lasted for the whole week preceding. When his appetite failed, the diet taken could not be well estimated, as it varied from day to day. He presented at this period, and subsequently, symptoms of enlarged liver and spleen, with some dropsical effusion into the peritoneal cavity; which latter symptom, I have no doubt, was connected with the diminished excretion of urea and urine.

CASE V.—The next case that I shall describe is that of a young man, named John Murphy, in whom the predisposing cause of the disease seemed to have been the practice of Onanism; he was under the care of Dr. Stokes, who concurs with me as to the probable cause of his complaint.

John Murphy, aged 25, admitted into Meath Hospital December, 1861.

Has had this disease four months; the canine appetite exists now two months; thirst was the first symptom; has a morning cough and dry skin.

The following observations were made during his residence in the Meath Hospital:—

(*a*) 13th, 14th December, 1861.—Passed 200 oz. fl. of urine; sugar = 7292 grs.; urea = 919 grs.

Previous Diet.

Bread, 1 lb., . . .	267 grs. urea,	. 4755 grs. sugar.
Beef, ½ lb., . . .	368 „	. —
Broth, 1 qt., . . .	46 „	. —
New Milk, 1 qt., .	116 „	. 354 „
	797 grs. urea.	**5109** grs. sugar.

With 3 oz. fl. brandy, and 2 grs. of opium.

(*b*) 20th, 21st December.—Weight = 136 lbs.; passed 273 oz. fl. urine; sugar = 9953 grs.; urea = 1075 grs.

Previous diet same as before.

(*c*) 8th, 9th January, 1862.—Weight = 134 lbs.; urine = 471 oz.; sugar = 13737 grs.; urea = 1277 grs.

Previous diet same as before, with addition of 6 oz. of bread, equivalent to 100 grs. of urea, and 1783 grs. of sugar; making a total of 897 grs. urea, and 6892 grs. sugar.

(*d*) 16th, 17th January.—Weight = 133 lbs.; urine = 277 oz.; sugar = 12119 grs.; urea = 970 grs.

Previous diet same as (*a*) and (*b*); urea = 797 grs.; sugar = 5109 grs.

(*e*) 23rd, 24th January.—Weight = 136 lbs.; urine = 233 oz. fl.; sugar = 8321 grs.; urea = 866 grs.

Previous diet same as (*c*); making urea = 897 grs., and sugar = 6892 grs.

(*f*) 30th, 31st January.—Weight = 137 lbs.; urine 220 oz. fl.; sugar = 7549 grs.; urea = 866 grs.

Diet same as before, with two eggs; making urea = 989 grs.; sugar = 6892 grs.

(*g*) 6th, 7th February.—Weight = 136 lbs.; urine = 230 oz. fl.; sugar = 8385 grs.; urea = 1006 grs.

Diet same as last.

(*h*) 13, 14th February.—Weight = 140 lbs.; urine = 230 oz. fl.; sugar = 8527 grs.; urea = 755 grs.

Diet same as last, with one ounce of brandy added.

(*i*) 20th, 21st February.—Weight = 143 lbs.; urine = 240 oz. fl.; sugar = 9545 grs.; urea = 997 grs.

Diet same as last.

(*j*) 6th, 7th March.—Weight = 145 lbs.; urine = 240 oz. fl.; sugar = 9130 grs.; urea = 892 grs.

Diet same as last.

(*k*) 13th, 14th March.—Weight = 142 lbs.; urine = 220 oz. fl.; sugar = 7700 grs.; urea = 866 grs.

Diet same as last.

(*l*) 27th, 28th March.—Urine = 190 oz. fl.; sugar = 7557 grs.

Diet same as last

Collecting together the preceding observations into one table, as before, I find the following:—

TABLE XIV.—*Case of John Murphy.*

	Date	Weight	Urine	Sugar excreted	Sugar ingested	Urea excreted	Urea ingested
a	1861. 14th Dec.	—	200 oz. fl.	7292 grs.	5109 grs.	919 grs.	797 grs.
b	21st Dec.	136 lbs.	273 oz. fl.	7953 grs.	5109 grs.	1075 grs.	797 grs.
c	1852. 9th Jan.	134 lbs.	471 oz. fl.	13737 grs.	6892 grs.	1277 grs.	897 grs.
d	17th Jan.	133 lbs.	277 oz. fl.	12119 grs.	5109 grs.	970 grs.	797 grs.
e	24th Jan.	136 lbs.	233 oz. fl.	8321 grs.	6892 grs.	866 grs.	897 grs.
f	31st Jan.	137 lbs.	220 oz. fl.	7549 grs.	6892 grs.	866 grs.	989 grs.
g	9th Feb.	136 lbs.	230 oz. fl.	8385 grs.	6892 grs.	1006 grs.	989 grs.
h	14th Feb.	140 lbs.	230 oz. fl.	8527 grs.	6892 grs.	755 grs.	989 grs.
i	21st Feb.	143 lbs.	240 oz. fl.	9545 grs.	6892 grs.	997 grs.	989 grs.
j	7th Mar.	145 lbs.	240 oz. fl.	9130 grs.	6892 grs.	892 grs.	989 grs.
k	14th Mar.	142 lbs.	220 oz. fl.	7700 grs.	6892 grs.	866 grs.	989 grs.
l	28th Mar.	—	190 oz. fl.	7557 grs.	6892 grs.	—	989 grs.

The weights in these tables are only correct within a pound avoirdupois, as they were not taken with the scales, but by means of a spring balance.

If we take from the preceding table the observations (*e*) to (*k*), inclusive, during which the dynamical equilibrium was established, we find the following results:—

1. The sugar ingested per day was 6892 grs.
2. The sugar excreted per day was 8451 „
3. The urea ingested per day was 976 „
4. The urea excreted per day was 893 „

There is a deficiency here of 1559 grs. of sugar, which it appears to me impossible to account for, except on the supposition that the proteinic compounds were resolved into sugar as well as into urea. In this transformation no carbonic acid is given out; on the contrary, if the view I have advanced—*D. Q. J. M. S.*, Vol. xxxii., p. 269—be correct, a small quantity of carbonic acid is retained.

The following appears to me to be a correct view to take of this case. Assuming the weight at 140 lbs., and the minimum excretion of urea at 2 grs. per pound, we find:—

1. Urea excreted, ...	893 grs.
2. Minimum for opus vitale, ...	280 ,,
3. Urea produced with glucose from proteinic compounds;	613 grs.
4. Corresponding glucose produced from proteinic compounds,	3065 grs.
5. Glucose ingested, ...	6892 ,,
	9957 grs.
6. Glucose excreted, ...	8451 ,,
Excess to be accounted for, . . .	**1506** grs.

If this be converted into carbonic acid, and excreted by the lungs, it will give:—

7. Carbonic acid formed from glucose, . . .	2008 grs.
8. Carbonic acid formed with urea of opus vitale,	1643 ,,
Total carbonic acid, ...	**3651** grs.

This is a quantity of carbonic acid less than half of what is excreted in health by a person of 140 lbs. body-weight. Unless, therefore, the deficiency were made up by the combustion of fat, which is quite possible, we should be forced to the conclusion that the excretion of carbonic acid fell far below its natural amount in health.

I made several, but quite ineffectual, attempts to estimate the amount of carbonic acid excreted per day, by the method of Dumas, and others; but came to the conclusion that no result as to quantity is of much value, unless it involve the total amount excreted in 24 hours. This important result has been recently attained by Pettenkofer and Voit, at Munich; and I would venture to suggest to these distinguished physicians the importance of placing a diabetic patient in their celebrated air-chamher for 24 hours, in order to determine with accuracy his excretion of carbonic acid. I feel satisfied that the result would show a serious deficiency, as compared with the excretion of health.

CASE VI.—Owen Butler,[a] aged 50, the father of six children,

[a] His brother died of same disease after one and a half-year's illness.

admitted into Meath Hospital August 1st, 1861; at 12 months before admission the symptoms of this disease appeared; and were attributed by himself to his occupation of threshing, which he has followed for 23 years, working at it from morning till night; has lost flesh, and strength, and eye-sight has grown dim since his illness; hunger is very great; sensation of a tearing in his stomach, and a pain in his forehead, are felt when his appetite is not satisfied; has a craving for fat, and drinks cod-liver oil with avidity. Has found milk to assuage thirst best.

On the occasion of his first visit to hospital the following measurements of his urine were made:—

1861, Aug.	5th, 6th,	390 oz.—	24 hours,	1042	sp. gr.
,, ,,	18th, 19th,	260 ,,	,,	1043	,,
,, ,,	21st, 22nd,	270 ,,	,,	1040	,,
,, Sept.	3rd, 4th,	205 ,,	,,	1041	,,

He perspires at night, often profusely; has no pulmonary symptoms.

Aug. 5th,	ordered Pulv. Dov. gr. x,	ter die.
,, 16th,	,, ,, ,,	quinque die.
Sept. 5th,	,, ,, ,,	sex die.

Aug. 19th, weight (naked) 131 lbs.

Sept. 9th, weight 128 lbs. On this day he left hospital in a fit of depression, saying he would go home to die. He has since[a] three times enjoyed and left the hospital, and is soon to return for a fifth visit. When he began to take 40 grs. daily of Dover's Powder he was "heavy and drowsy," and often vomited; but after the dose was increased to 50 grs. per diem he did not vomit, but got drowsy for a short time after each powder, and "started wonderfully in his sleep at night."

Second Visit.—Admitted again in Nov., 1861.

Nov. 28th, 29th,	160 oz. urine,	1047 sp. gr.	131 lbs. wt.
Dec. 13th, 14th,	188 ,,	1043 ,,	131 ,,

Third Visit.—Again in hospital; much emaciated, and feebler than on last visit; weighing 117 lbs. (naked); has pains and coldness in legs and thighs; feels as if his lower extremities were beaten with nettles; œdema sometimes about ankles; bowels moved every second day.

Observations.

1862, July 27th, 28th,	150 oz. urine,	1043 sp. gr.	117 lbs. wt.
,, Aug. 11th, 12th,	205 ,,	1042 ,,	120 ,,

[a] Written in January, 1863.

Admitted for fourth time, October 25th, 1862. Sight very much impaired; appetite failing; is now little more than ordinary hunger; thick mist before his eyes; legs perfectly cold from knees down; takes violent fits of shivering; sleep broken by starts and involuntary jerkings of muscles; gums soft, frequently bleed; has stings of pain along the back, and cramps in his thighs when wakening from sleep; has creeping and tickling sensations in nerves of both upper extremities. Brandy makes him sleep comfortably at night. Skin now always dry and coarse (used to perspire on first visit).

Observations.

Oct. 27th, weight 118 lbs. (naked).
Nov. 10th, „ 117 „ „

Left Hospital, December, 1862.

During the time that Butler was under my observation I made the following notes of his case:—

(*a*) 28th, 29th November, 1861.—Weight=131 lbs.; urine=160 oz. fl.; sugar=5000 grs.; urea=1050 grs.

Previous Food.

Bread, 1 lb., . . .	267 grs. urea,	4755 grs. sugar.
Beef, ½ lb., . . .	368 „	— „
Broth, 1 qt., . . .	46 „	— „
Milk, 1 pt., . . .	58 „	177 „
Porter, 1 pt., . . .	27 „	15 „
Tea, 1 pt., . . .	— „	— „
	766 grs. urea.	**4947** grs. sugar.

(*b*) 13th, 14th December.—Weight=131 lbs.; urine=188 oz. fl.; sugar=6854 grs.; urea=864 grs.

Previous food, same as last, with addition of pint of milk and pint of porter; making urea=851 grs; sugar=5139 grs.; 3 oz. fl. of brandy and 2 grs. opium also added.

(*c*) 20th, 21st December.—Weight=129 lbs.; urine=229 oz. fl.; sugar=7156 grs.; urea=1002 grs.

Previous diet same as last.

(*d*) 8th, 9th January, 1862.—Weight=129 lbs.; urine=180 oz. fl.; sugar=6300 grs.; urea=1102 grs.

Previous diet same as last, with addition of six ounces of bread, making the ingesta—

Urea=951 grs.; sugar=6922 grs.

(*e*) 16th, 17th January.—Weight=126 lbs.; urine=160 oz. fl.; sugar=6363 grs.; urea=966 grs.

Previous diet same as last.

(*f*) 23rd, 24th January.—Weight=128 lbs.; urine=205 oz. fl.; sugar=6523 grs.; urea=1076 grs.

Previous diet same as last.

(*g*) 30th, 31st January.—Weight=128 lbs.; urine=188 oz. fl.; sugar=6854 grs.; urea=1110 grs.

Previous diet same as before, with the addition of two eggs, making the ingesta—

Urea=1043 grs.; sugar=6922 grs.

(*h*) 13th, 14th February.—Weight=129 lbs.; urine=204 oz. fl.; sugar=7285 grs.; urea=1071 grs.

Previous diet same as last.

Collecting together, as before, these results into one table, we find:—

TABLE XV. *Case of Owen Butler.*

	Date	Weight	Urine	Sugar excreted	Sugar ingested	Urea excreted	Urea ingested
a	1861. 29th Nov.	131 lbs.	160 oz. fl.	5000 grs.	4947 grs.	1050 grs.	766 grs.
b	14th Dec.	131 lbs.	188 oz. fl.	6854 grs.	5139 grs.	864 grs.	851 grs.
c	21st Dec.	129 lbs.	229 oz. fl.	7156 grs.	5139 grs.	1002 grs.	851 grs.
d	1862. 9th Jan.	129 lbs.	180 oz. fl.	6300 grs.	6922 grs.	1102 grs.	951 grs.
e	17th Jan.	126 lbs.	160 oz. fl.	6363 grs.	6922 grs.	966 grs.	951 grs.
f	24th Jan.	128 lbs.	205 oz. fl.	6523 grs.	6922 grs.	1076 grs.	951 grs.
g	31st Jan.	128 lbs.	188 oz. fl.	6854 grs.	6922 grs.	1110 grs.	1043 grs.
h	14th Feb.	129 lbs.	204 oz. fl.	7285 grs.	6922 grs.	1071 grs.	1043 grs.
	Means,	**129** lbs.	**189·2** oz. fl.	**6542** grs.	**6229** grs.	**1030** grs.	**926** grs.

This case presents some features strikingly resembling that of Owen Murphy, particularly as respects the almost complete equality of the sugar excreted and ingested. This, however, I regard as an accidental circumstance, as the excretion considerably exceeded the ingestion in the cases of M'Nee and John Murphy.

Assuming the equality of this ingestion and excretion in Butler's case, we have to account for the excretion of carbonic acid by the decomposition of the proteinic food. This must take place either by the natural action of health, equation (4), (*D. Q. J. M. S.*, Vol. xxxii., p. 272), or by that of the disease which I have supposed in equation (1), (Vol. xxxii., p. 269); in either case it is insufficient to produce the carbonic acid required.

1. On the supposition of healthy production of carbonic acid, the urea excreted, 1030 grs., would develop only 6043 grs., whereas the lowest minimum of health requires 9100 grs. of carbonic acid.

2. If the proteinic compounds produce both urea and glucose, it can be shown that in this case also the carbonic acid is deficient.

We have on this supposition—

1. Sugar ingested, ...	6229 grs.
2. Sugar abnormally formed with 770 grs [1030 minus 260] of urea, ...	3850 grs.
Total, ...	10,079 grs.
3. Deduct sugar excreted, ...	6542 grs.
	3537 grs.
4. Carbonic acid produced from last found sugar, ...	4716 grs.
5. Add carbonic acid produced as in health, with 260 grs. of urea, min. op. vit., . . .	1525 grs.
	6241 grs.
6. From this we must subtract 565 grs. (equivalent to 770 grs. urea), retained, ...	565 grs.
Total carbonic acid, ...	**5676** grs.

Whichever view, therefore, we take of the question, there appears to be in diabetes mellitus a deficiency in the excretion of carbonic acid.

I greatly regret my inability to confirm or disprove this conjecture, which is not without practical interest from its connexion with the theory of phthisis, and I hope others who have the means will not neglect to try the experiment.

REMARKS

ON THE

LOSS OF MUSCULAR POWER

ARISING FROM THE ORDINARY FOOT-CLOTHING NOW WORN,

AND

ON THE MEANS REQUIRED TO OBVIATE THIS LOSS.

BEING

A PAPER READ BEFORE THE BRITISH ASSOCIATION AT CAMBRIDGE, OCTOBER, 1862.

BY JAMES DOWIE,

AUTHOR OF "THE FOOT AND ITS COVERING."

LONDON:
ROBERT HARDWICKE, 192, PICCADILLY.
1863.

of mental disease.

NOTICE.

The following paper was not intended for publication as a pamphlet; but shortly after it was read at Cambridge, I was applied to by several eminent men for copies, with a view to follow up the inquiry. I have felt it my duty to respond to this request.

JAMES DOWIE.

455, *Strand, London.*

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, HELD AT CAMBRIDGE, OCTOBER, 1862.

(From the *Lancet*.)

A PAPER was now read from Mr. Jas. Dowie, being "Remarks on the Loss of Muscular Power, arising from the ordinary foot-clothing now worn, and on the means required to obviate the loss." A pair of regulation army boots were shown, and a pair with Dowie's improvement, which consisted in their possessing elasticity of the sole in front of the heel, partly through the agency of india-rubber, and in having the proper shape of the foot, thus differing from the army boots, which were straight in the sole and solid throughout. Very much discussion followed, including amongst the speakers, clergymen, physicians, travellers, and others, who gave their experience as to which were the most comfortable boots to wear. The author's improvement was considered a good one by the majority of the speakers.

ON THE

LOSS OF MUSCULAR POWER.

THE locomotive function of the human foot and the movements of its several parts are without a parallel in the animal kingdom; the wonderful mechanism of the whole being so exquisitely adapted to the grand design of the system as justly to command the admiration of all who have examined its anatomy and physiology.

In the following paper on defective muscular development and the loss of muscular power, arising from the foot clothing now generally worn, and on the improvements required in the construction of the same to obviate losses of this kind, the grand object I have in view is, to cultivate by experimental as well as by scientific inquiry a more enlightened acquaintance with the physiology of the human foot and with the manufacture of clothing material, and of a covering, both constructed on scientific principles, harmonising with the functional requirements of the inferior extremities. The want of information that prevails on this subject is very remarkable. I have even had workmen so ignorant as not to know that there was any material difference between the last on which the boot was made and the foot on which it was to be worn; and although I feel somewhat bashfully diffident in saying it, it is much to be feared that too many wearers are not much better educated in this respect—the force of fashion diverting from their normal course the *laws of nature.* When fashion is thus allowed capriciously to deform the feet, it evidently indicates a perverted taste on the part of the public; and perhaps Social Science has no greater difficulty to contend with than to turn the current of fashion into its proper channel in the shoeing of mankind.

The more prominent characteristics of the boots and shoes now commonly worn demanding notice, are—*rigidity of sole from the tread backwards, high heels,* or a greater thickness of sole under the heel than under the tread or metatarsa-phalangial articulation—the peculiar *curvature* of the sole both longitudinally and laterally, the former technically termed in trade phraseology, "the spring of the last" and the goose-toed form of the uppers, as at the period when Dr. Camper wrote his celebrated minor Essay on "The best form of shoe."

Into the details of construction of form of these several parts it will be unnecessary to enter, as they must be familiar to all. I shall, therefore, at once proceed to show how they affect the foot in infancy, youth, and manhood generally; but, for the sake of

perspicuity, I shall take for illustration the feet of children when first shod; those of "the ploughboy," and the feet of our soldiers, policemen, and volunters, more especially the *soldiers,* because they are selected as free from blemish, but afterwards destroyed by imperfect shoeing. The same course of illustration will be preserved under the subsequent head of improvements to obviate present defects.

The tender feet of children when first shod on the objectionable plan in question sustain a threefold injury;—*first,* the normal development of parts is prevented; *second,* often much neglected before they are laced into boots, rigid under the tarsus, and so pinched at the toes as to deprive the anterior part of the foot also of its natural movements and elasticity, rigidity of structure and deformity are cultivated; and *third,* thus weakened and reduced in strength in every way, the muscles, ligaments, &c., of babies' feet are called upon to perform an extra amount of work in walking. There is something so unreasonable in this, and even unpardonably cruel, as to call for special animadversion, for many a helpless little one is thus lamed for life.

This will appear still more manifest when we come to examine the proper method of shoeing and training at this interesting period.

The English ploughboy, in heavily ironed "highlows," driving his team in sticky ground with large balls of clay attached to each foot, furnishes an instructive example to our modern professor of gymnastics. Agricultural labourers form a very large and interesting section of society, and here we have a practical illustration of the physical training of their inferior extremities, satisfactorily accounting for their deformed feet and calfless legs long ago pointed out by Sir Charles Bell. In infancy the legs are disproportionately short as compared with the trunk or body; and just when they begin to grow rapidly and when every attention is requisite to cultivate muscular development, strong ligaments, and healthy nervous action, we practise the very reverse on the stamping, plodding, but cheery ploughboy. Viewing the agricultural population in a national light, and reflecting how much they are dependent upon muscular strength from the large amount of heavy work which they have to perform, and how much the general public is interested in the timely performance of this work in seed time and harvest, the obvious conclusion forces itself upon our notice that there is involved in this most objectionable system of shoeing youth not only a shortsighted economy, but a serious sacrifice or deterioration of race that demands a thorough investigation by the Royal Agricultural Society and other societies, whose special function is to guide the wheel of progress in matters of this kind. Nor is this loss confined to our rural districts, for the youth of our labouring classes generally are in a similar position with the plough-

boy. Few exciting causes interfere more injuriously with the general health and constitution than the deforming process to which the feet are thus subjected; and there cannot be a doubt that much of the bad health and inability to perform the daily amount of work, and consequent disappointment and losses arising therefrom, are traceable to this source. Even amongst the higher classes who ought to know better, the malformation of the feet and legs at this period of life is in the highest degree reprehensible.

In the example of the soldier, the volunteer, and policeman, the foot has arrived at maturity of growth; so that if the men have been examined, and those only chosen for the public service whose feet are found free from blemish—as is the case, at least, with the former, the regular army—the effect produced by the regulation boot now worn is somewhat different from that of the previous two illustrations. Thus, in the *first* place, the result is now, atrophy of muscle, ligament, nerve, and tissues of the foot generally. In the *second*, deformity as before, but now attended with the long dark catalogue of maladies to which the body is subject in declining life; and *third*, muscular weakness, but now with a growing prostration of strength that annually becomes more and more difficult to recover by rest; while the waste of motive power in progression and the tear and wear of animal mechanism increase in a corresponding ratio. In cases of robust health and strong constitution, the feet and general health of the soldier may fight the daily battle of the regulation boots for a few years, when they enjoy regularly, during the stated periods of rest, time to recover partially their normal strength, but generally speaking, the result is otherwise; while, with hardly an exception, the feet in active service are the first part of the system that breaks up and gives way before the strong tide of hostilities.

Nor is it surprising that such should be the case. Indeed, the contrary would be so; for when the feet are thus clothed, the wasting of the girder ligaments of the plantar arch, and the general atrophy of tissue that takes place, must of necessity not only reduce the powers of progression, but also break up the whole mechanical structure of the foot. And this is just what daily experience informs us is the actual case with the British soldier; for when fighting the battles of his country, the mortality from foot lameness is greater than from any other cause, and the same fatal result is experienced in the armies of all nations thus shod. It is certainly humbling to think, that England should treat her armies thus in the present era of her history, yet such is fact. And this, too, it must be observed, is not the only humbling view of the matter, for the efficiency of the soldier thus shod is greatly reduced, as will subsequently be shown when examining this part of our subject experimentally.

I now enter upon the more agreeable part of my paper — the principles on which the human foot should be clothed. Following the order of illustration formerly adopted, the grand object in infancy is to train the child to stand upright upon the tripod bearings of its feet, so as to cultivate the normal development of the several parts with a view to proper shoeing and the preservation of form as soon as it has thus learned to stand. Children should never be too early shod or even allowed to stand upon their feet; for at this early period of life the bones and every part of the structure are soft and unfit to bear the superincumbent weight of the body, or undue pressure in any direction. Many attribute the going over the shoe to the outside or inside to the imperfect construction of the covering, but this controversial question may soon be disposed of, for very many children go over the heel before they ever wear a shoe.

The physical training of the feet and limbs of infants on the knee, and when they first begin to sprawl about and learn to stand, is thus a very important branch of nursery education, and should never be neglected either by mothers or the family doctor; for when they are so at this period, and deformity established, proper shoeing afterwards is hardly possible. "The proper training of the young sprig" is a cardinal maxim with the gardener; and if this is essentially necessary to success in horticulture, how much more important is the reduction of the principle to practice in the training of children's feet, and indeed every member of the body when they first begin to grow.

In the case of the ploughboy, the normal development and movements of the several members of the foot must be duly attended to and provided for in the clothing in order to obviate present defects and losses. No doubt, when the ploughman has a large family, the question of expense is one that frequently proves difficult of solution; and the common conclusion arrived at, that the ploughboy's "high-lows" must serve for twelve months—must be thick, rigid, and heavily ironed to do so—and must not exceed a certain price, at the same time, are all items that exclusively belong to one side of the balance sheet; and, therefore, are insufficient to prove the soundness of this conclusion; for when we examine the other side, and sum up the losses arising from imperfect development, weakness, extra tear and wear of muscle, reduced standard of health and amount of work done, they evidently do more than turn the balance the other way. But this is not the right view of the ploughboy's case; for the practical solution of the question of expense resolves itself into one of two things—either that by proper shoeing and physical training he will be able to gain two pairs of "high-lows" more easily than he now gains one; or else that "high-lows" may be constructed on principles so as to provide for the requirements

of the foot, and yet last longer and be found cheaper in the end than the thick rigid ones now worn.

Under the next head of a suitable covering for the full grown foot, we shall confine our remarks to the case of the soldier for reasons already given. And here the only doctrine that can reasonably be taught is, that when recruits enter the public service with sound feet, the public ought to provide regulation boots that will preserve them in this efficient state of health. This is no less the duty than the interest of the Government, so that when officials advocate otherwise, either they have some ulterior object in view that cannot be brought into daylight, or else they are unqualified for the office they hold. No doubt the pecuniary question of expense is no secondary one in the clothing department of the public service; but the difference between the price of the regulation boots now worn and that of efficient foot gear capable of preserving the feet in health and strength, can never be placed in the scales; for to this difference another must be added, viz., the difference between the cost of work done by lame soldiers unfit for duty, including the extra expense of the medical and conveyance departments, and that done by healthy active soldiers always at their post in the day and hour of their country's danger. In point of fact, practically considered between the two, no just comparison can be drawn, for a lame soldier is tenfold worse than no soldier at all. And exactly the same thing may be said of the volunteer and policeman.

But the pecuniary question under consideration is susceptible of another and a more satisfactory solution. This is more especially the case when it is examined as a public one in the light of economy; for the prime cost of a thing, apart altogether from its intrinsic value, can never be separately estimated under such a view from its durability. Now, if proper foot clothing last the soldier, volunteer, and policeman, longer than what they now wear, the former may be cheaper in the end than the latter; and we have no hesitation in saying that experimental evidence is forthcoming in favour of this solution, as will immediately be shown. In this respect, therefore, the public balance-sheet will shortly rectify itself on the same commercial principle that all private balance-sheets generally do.

I now come to the last and not the least important and interesting division of my subject:—its experimental investigation, and how such is practically being done. The physical training movement has proved itself a complete success in the estimation of the British public—much more so than it did in the days of ancient Greece and Rome, because more scientifically prosecuted—and our modern professors of gymnastics will soon experience no difficulty in settling the question of how the human foot should be clothed. Indeed, the problem is already fast being

solved in accordance with the writings of Sir Charles Bell and Sir Benjamin Brodie; for the moment the wasted and distorted muscles and ligaments of the foot are liberated from the thraldom of rigid leather, they slowly regain their normal symmetry and functions. The neglected child walks straight upon the tripod bearings of its feet; the rapidly growing limbs of youth no longer resemble drumsticks, but exhibit finely developed calves and thighs; while the feet of others in the prime of life, and even when well advanced in years, are like the eagle renewing their age, and all this through the instrumentality of physical training. And this, too, is not all, for experiments are now being made to ascertain the retarding force which the regulation boot of the army applies to the heel of the soldier in marching, which is found to be several pounds! In other words, it takes 28 lb. to bend the army regulation boot exhibited, while 2 lb. bend another constructed on principles adapted to the locomotive function of the heel and instep and the physical training of the foot generally; so that there is a difference of 26 lb. against the former and in favour of the latter. Thus, a soldier in his regulation boots is compelled to carry something like an equivalent to 26 lb. attached to each heel more than those who wear the boots that are constructed on sound principles, and these data are equally applicable to volunteers and policemen. A contrast so strikingly anomalous obviously calls for practical inquiry; for weights thus attached to the heels of British soldiers and volunteers, when called upon to charge the enemy, could never be intended to increase the efficiency of the former, but the contrary, to ensure the triumph of the latter; while to render such doubly sure, the muscular strength of the feet of the soldier and volunteer is greatly reduced by atrophy prior to making the charge! As to weights purposely attached to the heels of the policeman when the hue and cry of "catch thief" is raised, the proposition, if it were not matter of fact, is too ludicrously absurd to be seriously entertained in the present era of progress; yet such is really matter of fact, experimentally ascertained. As already hinted, it is certainly high time the professor of gymnastics was professionally engaged in these several departments of the public service.

As to the practice now in daily operation of clothing the human foot, so as to promote the physical training of its several locomotive members as referred to above, it has for long been successfully followed by myself; and I shall allow the facts of the case briefly to speak for themselves, as specimens of the outer and inner coverings are both present, while thousands of them have been worn for many years by men of the highest rank and scientific attainments, some of whom reside in Cambridge and may be now present—men who are qualified to judge for themselves, and therefore would not be imposed upon either as to intrinsic or pecuniary value. From

their elasticity and freedom of wear, there being no grinding action on the ground or overstretching of the uppers, they prove themselves more durable and cheaper than the ordinary boots. While injured feet in every age of life have been and are being restored to health and usefulness, I shall only further add under this head that there is now no patent on the boots; and it will afford me great pleasure to see the principle taken up by the trade generally in Cambridge and every other place, so as to give the public the full benefit of their use, which is very warmly recommended by the medical profession and those practically interested in the physical training and volunteer movements; and it only remains for me to point out the *modus operandi* as to how distorted feet are restored to their natural state, and healthy ones preserved as such.

That which chiefly distinguishes these boots from the ordinary ones, is the construction of the sole under the instep, thereby giving this most important part of the foot free play. It not only does so, but it also sets free the heel bearing, and the two metatarsa-phalangial bearings (the ball of the great toe and the ball of the little toe), thus allowing them to perform their respective functions in a manner not enjoyed in the rigid soled boot. It is not very easy explaining within the scope of a paper of this kind the beautiful mechanism of the instep, and how it adapts itself by its universal hinge joint movement to the tripod bearings of the foot just mentioned; but when we examine the movements of the nude foot, it will be readily understood that the three do not move in the same horizontal plane or remain equidistant from each other in walking. We shall thus perceive that in the ordinary boot there is here a natural law violated in several respects, but that in the other the demands of this law are complied with, comparatively speaking, the longitudinal and lateral elasticity of the arch of the foot being preserved.

Again, you will observe that in the one boot where the three bearings are rigidly fixed, the toes turn up ; but in the other they are straight, as is the case with the nude foot when resting on the ground ; while the heel easily bends upwards, thus complying with the natural movement of the foot and its tripod bearings. Were the sole of the former not turned up but made straight, it could not be worn ; the curved form of sole, however, enables the wearer to rock from heel to toe, and from foot to foot, with a jolting action.

Now, the consequences of this are soon told, for the padding of the ball of the great toe and little toe is overstretched, owing to the toes being turned up ; so that by this jolting action abrasion takes place, hence the calosities and abnormal thickening of the padding and other painful deformities experienced. In the other boot, when the foot touches the ground, the toes and padding of the anterior bearings are in their natural position, so that they suffer no harm ; and the reason why feet that have

been in the former or rigid boots are restored to health when put into the latter, is the normal freedom of movements which they enjoy—the several parts being allowed and even called upon to perform their respective functions. All abnormal matter is thus removed according to the natural law of the tear and wear of the system generally ; while a healthy reparative process commences which gradually restores the several parts to their normal state of health and usefulness — the whole of this salutary work being done in accordance with the principles involved in the physical training of every member of the body.

Such are the few observations I have ventured to make on the subject which heads my paper, as "The British and Foreign Medico-Chirurgical Review" of July last justly remarks : "The great error in all boots and shoes made upon the system now in vogue in all parts of the civilized world is, that they are constructed upon a principle of bilateral symmetry." No little difficulty will be experienced in getting out of this error, as the whole of the labour in last-making is not only now organized to turn out lasts of this form, but it is also naturally and more easily performed, while it is also natural for the working shoemaker to form his shoes on the same erroneous principle.

It is an error, too, natural for fashion to patronise, and for an unthinking public to follow, just because of its "bilateral symmetry." But a far greater error than this exists in the construction of boots with high heels, a rigid waist, and curved sole; thus depriving the instep and the tripod bearings of the foot of their respective normal functions; for in doing so we not only distort the foot but transfer the function of the muscles of the calf of the leg to those of the pelvic region, thus sacrificing the economy of muscular power and the dignified elegance of erect human progression, interfering at the same time most injuriously with the lumbar region and the general health of the body. The removal, therefore, of bilateral symmetry, however necessary, would only effect but a very small and fractional part of the great work of reformation required in the proper shoeing of man. Practically speaking, it would effect almost none of the reformatory work at all—for, as we have shown, if the interior of the boot corresponded to the exact form of the foot, the anterior part or toe being straight instead of curved upwards, the wearer of such a boot could not walk; and if the toes are turned up in the boot so as to correspond to the "spring of the last," then the metatarsa-phalangial articulations, and the two anterior bearings at the balls of the great toe and little toe, suffer the most afflicting and painful injury the foot sustains. Many who have got their boots made according to the form recommended by Dr. Meyer in his work, "Why the Shoe Pinches," have experienced the soundness of the above conclusion and have since come to me and acknowledged they were rather worse than better,

the toes although relieved at the points being more painfully pinched at the roots than before. In the physical training of the foot, its beautiful machinery, like all other mechanical systems, must be studied as a whole, from a physiological point of view, before practical success can be attained. This is the keystone of the arch; and, like the keystone of the plantar-arch itself with its girder ligaments, it must be thoroughly understood both as to form and function by its owner before we can expect to see suitable provision made for it. In other words, people must make themselves acquainted not only with outward form, but also with the internal mechanism of their feet and the specific function the several parts have to perform, before they can expect to arrive at a satisfactory conclusion as to how they should be provided for in the clothing, and the loss of health and strength they sustain by wearing foot gear constructed on erroneous principles.

It is evident, therefore, that the manufacture of lasts, boot-trees, and shoeing material on sound principles, and a covering adapted to the locomotive functions of the human foot, are questions not unworthy of public consideration at the present time, and of the professional investigation of scientific institutions, educational seminaries, and national seats of learning—such as Cambridge.

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THE FOOT AND ITS COVERING.

BY JAMES DOWIE.

"Is the proper conservation of the natural form and functions of so valuable a portion of the human frame as the foot not a worthy subject of consideration for the philanthropist and medical man? Is it not a strange reflection, so far are the feet of all persons in our own country and time deformed by the voluntary and unnecessary adoption of an improper form of covering, that in Europe from the antique alone any knowledge of what is beautiful in the adult human foot can be derived.

"'We bestow reasonable compassion upon the fate of the Chinese women, who dislocate their feet in obedience to the dictates of a barbarous custom, and yet we ourselves have submitted complacently for ages to tortures no less cruel.' So the Dutch anatomist wrote a century ago, and it is said by one of our present authors (Dowie), '*that the boots and shoes of the present day are even, if possible, more objectionable than those of the time when Camper wrote upon the subject.*' And are these statements exaggerated? We think not.

"We are much indebted to Mr. Dowie for bringing before the English public the philosophical essay of Camper, which contains many valuable suggestions. —*Medico-Chirurgical Review.*

"THIS work is not of a strictly professional character, but we feel bound to notice it—albeit the production of an enthusiastic disciple of St. Crispin—on account of the practical importance of the subject of which he treats both to the profession and the public. '*Ne sutor ultra crepidam*' is a time-honoured adage; but who so fitted to expatiate upon the last as the cobbler who sticks to it? and Mr. Dowie has evidently done so with all his might, not forgetting, however, as is too often done, the difference between a highly elastic bony arch and a rigid piece of wood. Camper's essay on 'The Best Form of Shoe' enters at length into the anatomical details of the foot, and the method in which progression is effected, showing that the foot both lengthens and expands every time it touches the ground, and therefore that a shoe to be suitable must make proper allowance for the consequent change of form.

"Mr. Dowie gives some information and hints which may be of service to most medical practitioners, and specially to those who have charge of men whose efficiency must depend in great part on their powers of progression—viz., soldiers and police. To all pedestrians it must be an object to have an easy shoe, and in the present day of universal military ardour and hebdomadal marchings out, this little contribution may prove a useful adviser upon the subject."—*Lancet.*

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"Mr. Dowie in his work recognises the principle of making the sole of the shoe correspond to the shape of the foot; but his great claim to be considered a reformer consists in his introduction of a piece of elasticated leather into the middle of the sole of the boot or shoe. By this simple and ingenious contrivance, he gives to a thick soled boot or shoe all the flexibility of a slipper, and the foot in walking retains all its natural springiness. None but those who have tried them can form a notion of the comfort and pleasure it is to walk in thick soled boots, constructed on Mr. Dowie's principle, after having been accustomed to wear the ordinary stiff-soled shoes."—*The British Journal of Homœopathy*.

ROBERT HARDWICKE, 192, PICCADILLY, LONDON.

THE

PATHOLOGY OF GENERAL PARESIS.

By W. H. O. SANKEY, M.D. Lond.

The term General Paresis, proposed in this Journal by Dr. Ernst Salomon, in place of general paralysis, appears to have been well received. It possesses the advantage of being distinct, and not likely to lead to confusion, and is therefore adopted here.

Perhaps no part of psychological medicine has of late received the same amount of attention as this disease. The well-worn excuse, therefore, that a disease so familiar to the specialty is still unknown to the general practitioner of medicine, must be abandoned; and, on the contrary, a writer on the subject may now take it for granted that there is no need to speak of the symptomatology.

The present article will be confined to an examination of the theories, views, &c., which have been lately put forth upon the pathology of the disease.

The following questions, or opinions, are to be found scattered through the various authors who have written on general paresis:

1. That the disease is of modern origin, or at least much more prevalent at the present day than formerly; that it is more common in certain countries, districts, climates, &c.

2. That general paresis is a complication of the different forms of insanity; that the paralytic symptoms are epiphenomena engrafted upon the original disease, and are in fact the means through which insanity often terminates fatally.

3. That, on the contrary, general paresis is a species—a *morbus per se*—entirely distinct, therefore, from all other kinds or forms of mental disease.

4. That general paresis never occurs but in connection with some form of mental aberration, as mania, imbecility, &c.

5. That the disease is not insanity complicated with paralysis, but rather a paralysis complicated with insanity.

6. That cases occur entirely without mental disturbance.

7. That there are two distinct forms—one with and one without delirium.

8. That there exist various forms, and a pseudo-form.

These different propositions may be classified under two heads. 1. Those relating to the nature of the disease; and 2, those relating to its diagnosis. To the first category belong Nos. 1, 2, 3, 4, 5, and 6, 7, and 8 to the latter.

With respect to the etiology of the disease, Dr. Skae, no longer ago than 1860, in his concise article in the 'Edinburgh Medical Journal,' still alluded "to the difficulty which he found to exist among physicians generally of recognising the disease when it exists;" and such a difficulty has in itself a pathological interest and signification, in two ways, viz., in the first place in connection with its history, and secondly, with respect to its prevalence. Since the complete recognition of general paresis is really of only forty to fifty years' date, it may be asked—Is it a new disease? for if so, we must look for its causes in something of the same date, as modern habits of life, modern hygiene, &c. But on this point there is sufficient evidence at once to settle the question that the disease is old, and that its diagnosis only is modern. Some writers believe they recognise the description of it in Cælius Aurelianus. The following is extracted from our old English author, T. Willis, who wrote in 1672, and seems to have been written with a certain familiarity of all the phenomena of the disease:

"Observavi in pluribus, quod, cùm cerebro primùm indisposito, mentis hebetudine, et oblivione, et deinde stupiditate et μωρώσει afficerentur, postea in paralysin (quod etiam prædicere solebam) incidebant, ... propterea enim, prout loca obstructa magis, aut minus ampla fuerunt, aut paralysis universalis, aut hemiplegia, aut membrorum resolutiones quædam partiales accidebant. . . .

"Particulæ oppilativæ à cerebro delapsæ, inque medullam oblongatam provectæ, nervos quarundam facies partium musculis destinatos subeunt, inque ipsis spiritum vias obstruendo, linguæ paralysin, modo in his aut illis, oculorum, palpebrarum, labiorum, aliarumque partium musculis resolutionem patiunt."—Cap. ix., p. 280, 'De anima Brutorum,' &c. Studio Thomæ Willis, M.D., Amstelodami, MDCLXXII.

These passages, and their context, carry back the date of the observation of the symptoms a couple of centuries, and prove that the knowledge of their importance lay dormant for a century and a half; for it was more than 150 years after Willis wrote the above that Esquirol published his work, and to him is due the credit, though

he attributes it to Haslam, of attracting attention more pointedly to the disease.*

Secondly. With respect to the backwardness in its recognition, which undoubtedly has existed to a great extent, and perhaps does still unduly continue, the fact possesses a pathological import, inasmuch as the cause of the difficulty may be due to an immunity of certain localities, nations, or classes of persons from the affection.

Dr. Skae writes: "In the Asylum at Montrose, with about 300 inmates, there are at present no cases of general paralysis. I single out this case, in illustration of the different prevalence of the disease in different localities for this reason, that Dr. Howden, the physician of that asylum, having been four years an officer of the asylum under my care, I feel confident that he would recognise the disease with the same certainty and facility which enabled him always to find about twenty-five cases in the Edinburgh Asylum; and the fact cannot be referred to his seeing the disease with different ideas of it from my own."

Dr. Skae writes also, that he believes, "from facts which might be cited," that the disease is on the increase. It is well known, also, that certain parts of Europe are almost free from it. This difference in the prevalence in different localities, in the different sexes, and in different classes, is doubtless pregnant with signification, if its solution could be achieved.

But to leave the general question of the etiology of the disease, and to address our inquiries into the more important matter—the nature of the disease—we find the following opinions broached:

1. That the paretic symptoms are epiphenomena. This was the opinion of Esquirol; it was or is maintained by Delaye, Calmeil, Georget, Pinel neveu; by Griesinger, and by all the German school, as far as I am able to discover, and by most of the writers of the former period. A modification of this opinion is given by Dr. Skae, who writes, *loc. cit.*—"This disease may be described either as a form of insanity complicated with general paralysis, or as a general paralysis complicated with insanity."

2. It is argued on the other hand, that general paresis is a distinct morbid species. This is a more modern and, in France, the more generally received opinion. It was first enunciated by Bayle. It has been strenuously supported by Salomon in this journal, Parchappe, Jules Falret, Delasiauve, and others.

These two propositions appear to contain all that is really important on the question. The rest of the arguments or differences that have arisen in the discussions on the subject would seem to have turned

* The rest of the medical history of general paresis is given in Dr. Skae's paper, 'Edinburgh Medical Journal,' vol. v, p. 884.—See also Morel's 'Traité des Mal. Mentales,' p. 805; and Baillarger, 'Annales Medico-Psych.,' Oct. 1859, p. 511.

upon how much or how little is to be included under the title of general paresis.

The main propositions are such as may be fairly investigated by the usual method of clinical examination, and the question resolves itself into this—Is there a disease, general paresis, distinct from all other diseases in its etiology, progress, and pathology? The question is not whether the diagnosis of such disease is yet perfect and defined. Those who argue for the specific nature of the malady would not assert that they have arrived at the last analysis of this subject; but they would seem to assert that certain cases of disease, which can be described, in a very large proportion, have a common cause and pathology.

The clinical inquiry may be directed to the history, causes, progress, and pathology.

With respect to the history of the disease, if the symptoms are epiphenomena only, or complications engrafted upon another disease, or arise at any epoch during its progress; then, firstly, all second and third attacks of insanity should be equally liable to have the epiphenomena engrafted upon them as first attacks; and secondly, the symptoms should occur in old cases, or in cases in which the patient has been insane many years, as often as in cases of more recent origin.

Firstly, with respect to the occurrence of the symptoms of general paresis in cases of second attack. I find, then, since my residence at Hanwell, I have received 2280 patients, and out of these there have been 61 affected with general paresis. At Hanwell about 20 per cent. of the cases admitted are not first attacks. Out of the gross number, therefore, of patients received, 456 of my patients were affected with second, or third, or fourth attacks of their malady.

The ratio of cases of general paresis to the admission, is therefore 2280 divided by 61 or 37; and if general paresis affected the second admissions in the same proportion as the gross number of admissions, then $\frac{1}{37}$ of the 456 patients should present the well-known symptoms. In other words, there should be 12 patients among 456 affected with general paresis. Whereas, out of 61 patients whom I have found to be actually affected with that disease, there is not one who can be strictly said to be affected with a second attack of insanity. Out of the 61 there are five cases of equivocal kind; that is to say, two of the five were reported on admission to be labouring under a second attack of insanity. The particulars of the first case are as follows: C.C—, a married woman, separated from her husband and married to another man, who is an attendant at an asylum for the insane, was taken with the following symptoms: "she wandered away from her home, and went about into the other lodgers' rooms half undressed," and was unable to find her way back. She was considered insane and sent to a County Asylum. Her disease there was entered *mania a potu*. She was discharged after six months' residence, and she returned to cohabit with the attendant, who said she appeared pretty well on her discharge, up to the period of her admission into Hanwell, except on one or two occasions, when she exhibited certain symptoms of general paresis, which the informant, from his experience with the insane, was enabled to recognise. She "stuttered in her speech." The paralysis chiefly affected the tongue; at times she could not speak for several minutes; she "mumbled in her speech." "Since she left the asylum she has been gradually failing in her memory." She was admitted into the Hanwell Asylum twelve months after her discharge from the other public asylum, or eighteen months from the first appearance of any symptoms, and she died twenty months after admission, or thirty-eight from the commencement. This case was clearly no second attack, although it was so reported, but one in which there was simply a remission of the symptoms, the occurrence of such remissions being well recognised and fully admitted by every writer. The next case was probably of a similar kind, but not so well authenticated. A woman was seized with the pains of labour while away from home, and was delivered by the roadside, and shortly after became insane and was taken to the workhouse. The husband, an agricultural labourer, visited her there from time to time, and found her talking nonsense—"sillified, no ways raving." She got better, and returned home after nine months, and she was said to be cured. The husband considered her quite recovered, "but only more forgetful, and not so tidy as she used to be." One day, six months after this, on returning from his work he found her and all his children stripped stark naked. She was speedily sent to the asylum, and on admission had all the symptoms of confirmed general paresis. The other three cases, reported to be second attacks, were all patients discharged by myself, all known to be labouring under the symptoms of paresis when discharged. One was that of a married woman, also separated from her husband and living with another man. Her symptoms had undergone slight remission, and she was under an order to be removed to a distant asylum—the settlement of her husband. She was removed by her sons on the usual undertaking, and was readmitted after the lapse of fourteen months, having wandered away from her home and lost herself, and having been picked up by the police. The other two cases were discharged under the pressure of friends, and who remained out but very short periods—one a month only, the other nine weeks—so that, instead of 12 cases being found among the 61 cases of general paresis of patients who had been formerly insane, there really was not one *bona fide* example.

Secondly. If the paretic symptoms are epiphenomena only they should be met with as frequently among the old inmates of asylums as among the fresh cases. If these symptoms are to motility what imbecility is to the intellectual faculties, we ought rather to find general paresis more frequently developed in the old cases than in the recent. It has been, indeed, denied that true general paresis ever occurs in chronic cases, or cases of long standing; and there are states which closely simulate the true disease. But it must be also admitted that, in a small proportion of instances, the true case of general paresis is met with in patients long resident and long insane. Among the 61 cases analysed by myself, there are 2 in which the diagnosis was entered as general paresis; at the time one had been in the asylum twenty-one years, and one twenty-four years; and such occurrence is admitted even by Parchappe,* one of the strongest advocates of the special nature of the disease. And the argument is not that insanity will give an immunity from attack of general paresis, but that general paresis does not occur so frequently, and certainly not more frequently, in older cases.

Again. From an analysis of 105 fatal cases of general paresis, occurring in both male and female departments of this asylum, and in which the duration of the attack was accurately ascertained, I find that 69 terminated before the close of the third year, and 86 before the end of the fourth year; 13 only reached the sixth year, and 5 only lived beyond the eighth year from the first commencement of the symptoms of insanity; so that at the end of five years, about 90 per cent. of the paralytics were dead, but in five years only 31 per cent. of all cases taken generally terminated by death. If, however, paresis followed the ordinary cases of insanity, the duration of the paretic cases should be at least equal to ordinary cases.

Another mode by which the question may be tested, whether the disease be a distinct disease, a *morbus per se*, or whether the symptoms are mere addenda, epiphenomena, is in connection with its etiology. As far as I am aware, the subject has not been heretofore examined in the mode about to be mentioned. It is calculated, however, to throw additional light upon the subject, and the object of the present communication is not to advocate a particular hypothesis, but to sum up the evidence which can be derived from any source, and which may at all elucidate it. It is admitted that an hereditary tendency to insanity of some kind exists in some of the subjects of general paresis. Now, when a disease is communicated by any means, the disease received should be of the same kind or species as that from which it was derived—there should be an identity of disease transmitted. It must, however, be remembered that the character of the evidence with respect to hereditary transmission is not always very satisfactory. Moreover, there are very different degrees of hereditary consanguinity, and the proof or evidence cannot be so absolutely determined as in the case of infection by personal contact.

* 'De la Folie Paralytique,' p. 27.

In the communication of an infectious disease the seed is sown and germinates almost under our eyes, and a given species produces examples of the same species, with occasional variation of type only. But with hereditary transmission it is a matter of uncertainty both what species is sown and when it is sown. Moreover, as we have all the blood of more than one family in our veins, so we may inherit the ills of several of our ancestors; and since such morbid inheritances may lie dormant in the system for an indefinite period, there is more uncertainty whence a particular disease may have derived its origin. Or, to go back to the metaphor of the seed, though we have pretty strong convictions that a seed always produces its own species only, yet we find in fresh-turned earth, weeds previously unknown to a particular locality occasionally make their appearance, which would seem to have sprung up from seed of totally different kind.

Calmeil, who does not advocate the theory of the specific character of the disease, says one third of the cases of general paralytics come from parents or families in whom hereditary predisposition to insanity exists. In 1826 he wrote: "Some of the (plusieurs) patients affected with general paralysis belong to families in which there existed hereditary predisposition to insanity. But it is impossible to determine whether the disease is more common among such than among those in which there is no such tendency."—'De la Paralysie,' p. 370. In 1859 he writes ('Maladies Inflam. du Cerveau,' tome i., p. 272): "Many families are loath to confess to hereditary tendency to insanity, and we state roundly that a third of the patients with general paralysis come from parents either insane or paralysed." This appears to express the common opinion, but our present question cannot be determined by such general statements. I have collated 41 cases of females and 68 males affected with general paresis, in which the subject of hereditary tendency has been carefully examined. The cases of the females were patients of my own; the 68 males were patients of Dr. Begley. The history of each case was received directly from the relatives. In no case are the facts entered from the order of admission, and in which the details are furnished by relieving officers, &c., and neither my colleague nor myself collected the facts in particular reference to any line of argument. Hereditary tendency was found to exist in $\frac{1}{5}$th of the males and $\frac{1}{7}$th of the females, or in 19 cases out of the 109, or between $\frac{1}{5}$th and $\frac{1}{6}$th of the whole, or in $14\frac{1}{2}$ per cent. among the females, and 19 per cent. among the males, and $17\frac{1}{2}$ per cent. among the two sexes. But hereditary predisposition among all cases amounts to 20 per cent., instead of $14\frac{1}{2}$ per cent. among the females, and 22 per cent. instead of $17\frac{1}{2}$ per cent. among the males; so that, though hereditary tendency is found to exist as a predisposing cause to general paresis, yet it less frequently predisposes than other cases of mental disease.

M. Calmeil goes further, and asserts that the transmitting disease or the disease from which the general paresis has been inherited, may be of various kinds—in some cases mania, others melancholia, monomania, dementia, &c. He gives no data on which he arrives at this generalization, which is to be regretted. Nor were my own facts originally collected to elucidate the subject, and indeed it is not easy to collect such data, for though the histories are gathered in all cases directly from the relatives, they are often unable to say what form of disease the ancestor, or predisposing person, had. The term hereditary predisposition is in itself somewhat of indefinite signification. There are sources of error both as to the kind of disease and the degrees of consanguinity to be reckoned. Among 41 cases on which my own notes afford information relative to this point, hereditary predisposition is found reported in 6. In analysing the evidence of the 6 cases of hereditary predisposition 4 may be classified as of less doubtful character and 2 of more doubtful. Thus of four females, in whose cases hereditary predisposition was found to exist, the father of one was an epileptic; one had a sister insane; the third had two brothers paralysed; the fourth had an aunt "queer." Of the two patients whose cases are classed as of doubtful hereditary causes, one had a mother "insane at the last." The second had a sister a congenital idiot. Such is the evidence of hereditary predisposition among the females. Among the males hereditary predisposition was recorded, in 13 cases out of the 68, and my colleague is distinguished for the great care and impartial accuracy with which he collects his facts. I should class these 13 cases thus —in 8 the tendency was of the less doubtful character, 3 more doubtful, and in 2 the relationship and detail is not recorded. Of the 8 cases, the subjects of 6 had a parent insane, 3 of whom were said to be paralysed, 2 had an uncle and aunt insane. One of the patients, whose parent was paralysed, had two other members of his family stated to be affected in mind, one being an epileptic. The three of the more doubtful instances of hereditary transmission are—1, the father died of apoplexy; 2, a daughter committed suicide; 3, father had a brain fever. In the examination of the 109 cases, therefore, there was discovered evidence of a predisposition to insanity in 12 cases only, which were really unequivocal, and the consanguity was that from parent to child, or direct transmission, in seven cases, and all insane, and there was distinct evidence of paralysis in three of the seven. The evidences of transmission was presumptive only in the remaining 5 cases, the relationship being by uncle or aunt; in three cases; two said to be insane and one called "queer." The consanguinity was by brother and sister in two cases, one a sister insane, and the other two brothers paralysed. The evidence of hereditary transmission of paralysis itself, therefore, extends to 5 out of the 12 cases; and when we remember that the disease is one, which is not well known to the

general public, the above data are upon the whole favorable to the view that general paresis is distinct from other cases of insanity, both in the difference in degree by which it is liable to be transmitted, and also because there is a strong presumptive evidence that the species when transmitted is transmitted in kind.

Again, there are, or have been, at Hanwell, in the male and female departments, 55 patients bearing blood relationship to each other; 44 females and 11 males have had relatives in the asylum, all of whom have been known to me or my colleague, and the form of their disease personally verified. In one patient only did the symptoms of general paresis exist. This patient was also an epileptic. Her niece is still in the asylum affected with epilepsy, but without any symptoms of paresis at present.

Among the predisposing causes is included the peculiar epoch of life at which the affection commences, and this has been fully investigated by most authors, and is not found to differ materially from the epoch at which insanity generally commences. The different liability of the sexes is, however, well established, and adds considerable weight to the arguments for the special character of the disease. The disposition of mind or character may also act as a predisposing cause. It is not easy to reduce the data to a concise formula of expression, but I think there may be recognised among those who become affected with general paresis, a disposition or character in which the emotional feelings are not properly under control. Persons of this kind have been in some instances endowed by nature with strong emotions. Others have, by long indulgence in the exercise of these feelings, lost the due control of them, or have never possessed sufficient intellectual power to keep them in check. Whichever be the case, the animal part of their character becomes strongly expressed; they follow the bent of their inclinations; they are governed by their hopes; they are literally, whether taken in the good or bad signification of the word, sensualists. As examples of this kind of disposition, I find among my own patients, whose cases I have been examining, persons who are imprudent, reckless, extravagant, &c., and governed solely by their longings, desires, ambitions, appetites, and lusts; and certainly a very large proportion have committed sexual improprieties; many paretics also, as is well known, have previously indulged in drink.

Among the patients treated during the last few years were the following:

1. A young woman, of handsome exterior, at the age of eighteen became a mistress: passing from one man to another three times, and living on each occasion in the greatest luxury. At the age of thirty was deserted, took to drink, lived upon the proceeds of her furniture, became reduced to the lowest grades of vice and misery, and became insane.—2. A very handsome young female, was an

inmate of a public hospital, and attracted the attention of a medical student, who educated and married her. They ran through £10,000 in a very short period. The husband had to fly his creditors. She lived at first upon a pension allowed by his parents; she was found pursuing an irregular life; the allowance was stopped, and she became insane.—C. C—, married, and had a child at fifteen years of age, became irregular in her life, and was deserted by her husband, and she married another man, with the cognizance of the first husband, and also, latterly, of the second, who continued to live with her.—M. A—, a tradesman's wife, deserting her children, ran away with a gentleman, with whom she lived a very fast life. The paramour died of drink, leaving her £500, which she spent in three months, and became insane.—A married woman, æt. 54, formerly in affluence, deserted her husband, and lived with a porter at a railway.—A. S—, married at the age of sixteen, against the wishes of her parents; was ill-used by husband, and was syphilised by him. He deserted her; she supported herself by prostitution, following soldiers at barracks, and died of general paresis at the age of thirty. —A daughter of an opulent tradesman, at an early age, was found to be misconducting herself with more than one of her father's workmen, was reproved, and ran away from home. Was sent to various reformatories, but was always incorrigible. She became a prostitute by choice, pursued her course, became more and more abandoned, drank, and at length was sent to prison for theft. She died at the age of forty-eight of general paresis.

Out of 35 cases, of whom the history of the disease is complete, 11 are known to have led an habitually irregular life, with respect to sexual indulgence, and of 14 only was the information satisfactory as to the contrary state of things; and of these fourteen, one had had an illegitimate child in early life, but since, according to her mother, had lived correctly; and one other was a married woman, who left her husband on the day after her marriage.

Though the above evidence is not conclusive, it appears to show that the predisposing causes which lead to general paresis are of peculiar kind, and rather favours the opinion of the specific nature of the disease. It is corroborated by a fact, for the knowledge of which I am indebted to Dr. Conolly, who tells me that in his large experience he has never met with a case of general paresis among females of the upper classes in society. The predisposition to the disease would appear to stand in the following order, therefore. The most liable are—

1, males of the lower classes;
2, males of the upper classes.
3, females of the lower classes;
4, females of the upper classes.

And this order of sequence may be considered to be also that of the subjugation of the animal passions in the different classes.

With respect to the determining cause, M. Parchappe states that the disease is always caused by a concurrence of predisposing and determining causes, which are not, however, separably peculiar to the disease, but by their conjunction become so. The determining cause he considers to be any prolonged mental effort. In this category he includes all sensual indulgences, as drink, &c., and all those vices epitomised in the English terms of "fast life."

In the cases which have come under my own observation, moral emotions have appeared to have been the exciting or determining cause more frequently than the purely mental; for instance, I find recorded as exciting causes, "the conviction of a son for theft," "seduction and suicide of a daughter," &c. This does not appear to differ from the determining causes in other forms of insanity.

Morbid Anatomy.—The morbid appearances found after death in general paresis are (1) those found by the ordinary examination, or with the unassisted vision. And (2) the microscopical character of the various tissues. The former appearances have been repeatedly described by Parchappe, and most writers on the subject.*

But the question here is not whether general paresis presents anatomical lesions, but whether such lesions are special and confined to the form of disease, and differ from the appearances found in other forms of insanity. To examine into this question, a comparison has been separately undertaken between fifteen cases of general paresis and fifteen other cases of other forms of insanity selected indifferently, and the examination has been made in a particular manner, and always by the same observer—myself. The mode adopted requires some explanation. A table of possible morbid appearances, as far as could be foreseen, or experience had taught to be important for special observation, was first prepared; and each part of the brain has been, as it were, catechised by its aid. Thus, so far as the table goes, there is not only positive but negative evidence with respect to each appearance recorded.†

* 'Parchappe de la Folie Paralyt.,' p. 13. Dr. Skae, 'Edin. Med. Journal,' vol. v, p. 885. 'Annual Report Roy. Edin. Asylum,' 1854. Griesinger, 2 Aufg., s. 443.

† The table has been found greatly to facilitate the process of recording the morbid appearances, and not only of recording, but also of analysing them afterwards, which may be found of assistance to others. It will be seen that the table is arranged in the following method. 1, External characters, and 2, Internal. The internal appearances, are subdivided into those relating to the membranes, and 2, those connected with the brain substance; those latter again divided into the general and special characters of the cerebral matter. Under this arrangement, the particular characters are placed, and each concrete fact is numbered in the order of its sequence; the number, therefore, can be used as a symbol or algebraic formula for the particular morbid appearance: thus, the symbols B 25, 33, stand for the following facts, that the pia mater is abnormally adherent to the grey matter, and is thickened in its texture; but in analysing a number of cases, it is much easier to separate out all the

The following is the table relating to the head. Each concrete fact, it will be seen, has a symbol attached, as A 1, 2, &c. The 2nd column enumerates the frequency in which each appearance was found in fifteen cases of general paresis, and the other column the frequency in the fifteen other cases, and which consisted of the following forms of disease:—3 cases of melancholia, 1 mania, 1 folie circulaire, 2 monomania, 2 epileptic mania, 2 dementia, 1 senile imbecility, 1 imbecility and spinal paralysis, 1 imbecility following hemiplegia, 1 imbecility after epilepsy.

cases in which B 25 occurs than to go through each case separately, and by the arrangement B 25 will be always found in the same position with regard to the rest. It of course occasionally happens that a morbid appearance is confined to a portion only, that is fractional part of the brain, in which the symbol is written in the form of a fraction, thus $\frac{\text{B } 25}{a}$, a in this case standing for the anterior portion of one of the cerebral lobes. For in order to complete the system, a table of each known fractional portion of the brain as fornix, corpus callosa, &c., has been formed ,a Greek letter affixed to each item. In taking the notes, of course only the positive is stated and not the negative, bu tsince each brain is duly submitted to examination by each item, the symbols prove also the non-existence of any particular appearance as well as the presence of others.

Examination Post-mortem.	Symbol.	Fifteen Cases of General Paresis.	Fifteen Cases of other forms of Insanity.
Head I. External characters	*A*		
A. General characters			
Form of cranium	1		
Profile			
Frontal region large and occipital small	*a*	1	1
Frontal and occipital equal	*b*	9	8
Frontal region small, occipital large	*c*	4	6
Plan, or horizontal section			
Oval form	*d*	9	10
Circular	*e*	3	0
Egg shape, larger in front	*f*	0	0
" " behind	*g*	2	5
Elevation			
Vertex low	*h*	13	13
" high	*i*	0	2
Wide in parietal regions	*j*	0	0
Narrow in ditto, or conical head	*k*	0	0
Irregular form	*l*	0	1
Measurements average	—	5×6¼	5×6
Hair			
Natural	2	0	0
Much	3	5	7
Little	4	6	6
Colour			
Light	5	3	2
Red	6	1	0
Dark	7	7	7
Grey (degrees DDL, DL, DLL)*	8	3	5
Integuments			
Normal	9	14	15
Abnormal			
Infiltrated with serum	10	1	0
" " blood	11	0	0
Adventitious tissues			
Fatty tumour	12	0	0
Purulent collection	13	0	0
Periosteum			
Normal	14	15	15
Abnormal			
Injected	15	0	0
Solution of continuity	16	0	0
Bone			
Thickness normal Diplöe distinct	17	8	7
" abnormal			
Increased			
Dense. Diplöe indistinct	18	7	6
Spongy	19	0	2
Diminished in thickness	20	0	3
Solution of continuity			
Injuries	21	0	0
Diseases			
Caries	22	0	0
Absorption	23	0	0

* DDL, equivalent to two of Dark to one part of Light hair, &c.

Examination Post-mortem.	Symbol.	Fifteen Cases of General Paresis.	Fifteen Cases of other forms of Insanity.
Head I. External characters—*continued*.	*A*		
Vascularity			
Normal	24	10	11
Abnormal			
Increased	25	5	4
Diminished	26	0	0
Infiltration			
Purulent	27	0	0
Sutures abnormally open	28	0	0
II. Internal.			
A. Membranes	*B*		
1. Dura mater			
I. Normal	1	7	5
II. Abnormal			
Adherent to bone	2	4	3
to arachnoid	3	1	1
Altered in structure			
Increased in thickness			
Membranous	4	3	4
Bony	5	0	2
Diminished in thickness	6	0	0
Heterologous formations			
Cancer	7	0	0
Tubercle	8	0	0
Altered in colour			
Yellowish	9	0	0
Injected (degrees ′, ″, ‴)	10	1	1
Solutions in continuity	11	0	0
2. Arachnoid			
I. Normal	12	1	6
II. Abnormal			
Adherent	13	1	1
Altered in structure			
Increased or opake (degrees ′, ″, ‴)	14	12	4
Contents, abnormal			
Dry	15	0	0
Serous effusion	16	11	3
Lymph effused	17	2	1
Pus	18	1	0
Blood			
Fluid	19	0	0
Coagulated	20	0	1
Tubercle	21	0	0
Adventitious products	22	0	0
3. Pia mater			
On Surface of convolutions			
Normal (strips readily)	23	0	7
Abnormal (non-adherent)	24	7	7
Adherent to grey matter	25	8	1
Vascularity increased	26	15	7
„ diminished	27	0	2
Serum in meshes	28	9	5
Blood	29	1	0

Examination Post-mortem.	Symbol.	Fifteen Cases of General Paresis.	Fifteen Cases of other forms of Insanity.
Head II. Internal. Pia mater—*continued*.	*B*		
Pus effused	30	0	0
Lymph	31	0	0
Tubercle	32	1	1
Abnormally thickened	33	0	0
„ attenuated	34	0	0
Plexus choroïdes			
Normal	35	0	2
Abnormal			
Increased in thickness	36	0	2
Diminished „	37	0	0
Vascularity increased	38	4	3
„ diminished	39	0	0
Serum in meshes			
transparent	40	0	0
opake	41	0	1
B. Brain substance	*C*		
1. General characters			
Touch			
Weight			
Cerebrum	1	av. 34¼	35½
Cerebellum and pons	2	„ 5¼	5¼
Specific gravity			
Cerebrum, white substance	3	„ 1·039	1·041
grey „	4	„ 1·034	1·031
Cerebellum, white „	5	0	0
grey „	6	0	0
Consistence (generally) firm	7	3	5
„ flabby	8	3	4
Sight			
Colour, generally			
Dark	9	0	0
Pallid	10	0	0
Congested	11	8	5
Shape and form			
Regular	12	0	0
Irregular	13	2	1
Convolutions close	14	0	7
„ open	15	9	3
Atrophy simple	16	0	0
„ by pressure (not including pressure by limpid serum.)	17	0	0
Hypertrophy, or swollen brain	18	0	0
2. Special characters			
A. Grey matter	*D*		
1. Normal	1	0	0
2. Abnormal			
Colour, dark	2	8	3
„ light	3	3	11
Injected			
Suffused	4	12	6
Punctiform	5		

Examination Post-mortem.	Symbol.	Fifteen Cases of General Paresis.	Fifteen Cases of other forms of Insanity.
Head II. Internal—*continued.*	*D*		
Extravasated	6	0	0
Layers distinct	7	5	7
„ indistinct	8	10	6
Consistence firmer than normal	9	5	4
Softened			
Red	10 }		
White, creamy	11 }	0	4
Abraded or eroded (v. 15)	12	0	0
Solutions of continuity			
Morbid growths	13	0	1
Mechanical			
1. Before death	14	0	0
2. By removal of membranes	15	8	1
Atrophy, simple	16	1	0
„ by pressure	17	0	0
B. White matter	*E*		
1. Normal	1		
II. Abnormal			
Colour, dark	2	2	1
„ pale	3	4	3
Injected			
Suffused	4 }	8	8
Punctiform	5 }		
Extravasated (see 17)			
Consistence, firm, (degrees ′, ″, ‴)	6	8	4
„ softer			
Red	7 }	5	4
White	8 }		
Solutions of continuity			
a. Morbid			
I. Defined			
Cysts, containing			
Serum	9	0	0
Puriform fluid	10	0	0
Blood	11	0	0
Coagulum	12	0	0
Fibrine	13	0	0
Heterologous growths	14	0	0
Foreign body	15	0	0
Calcareous	16	0	0
II. Undefined or diffused			
Blood, extravasation	.17	0	0
Puriform fluid	18	0	0
Heterologous growths	19	0	0
b. Mechanical			
Injuries	20	0	0
Œdema	21	0	0
Hypertrophy	22	0	0
Atrophy, simple	23	0	0
„ by pressure	24	0	0
C. Vessels			

The greatest difference that, from the comparison, was found to exist, was in the frequency of occurrence of effusion beneath the arachnoid (B 16), which was found 11 times in the 15 cases of general paresis, and 3 times in the other cases. A similar discrepancy existed in the increased vascularity of the pia mater, which occurred in every case of general paresis, and in 7 of the other cases. Adhesion of the pia mater to the grey matter (B 25) occurred in 8 of the 15 cases of general paresis and in one of the other cases. This appearance is not, therefore, pathognomic of the affection. The next most frequent difference was found in the state of the convolutions, which were abnormally open and wider apart in 9 of the cases of general paresis, and in 3 of the other cases. Injection of the white substance existed in 12 of the cases of general paresis, and in 6 of the other cases. The colour of the grey matter was found to be darker than normal in 8 cases of general paresis, and in 3 of the other cases. The layers of the grey matter were indistinctly marked in 10 of the cases of general paresis, and in 6 of the other cases; and the white matter firm in 8 of the paretic cases, and in 4 of the rest. On the other hand, the periosteum of the calvaria was found more frequently normal in the paretic cases, in the proportion of 12 to 4 of the other cases. There was a difference also between the colour of the grey matter, which was of lighter colour than normal in 11 of the other cases, and in only 3 of the paretic; and the pia mater stripped readily from the convolutions in 14 of the other cases against 7 of the cases of general paresis.

These facts are evidence in favour of the difference of general paresis from other cases of insanity, although they fix upon no particular morbid appearance as distinctly pathognomic of the affection.

Microscopical Anatomy.—During the last few years there have been thrown out various surmises with respect to the condition of the grey matter of the hemispheres in general paresis. Since Parchappe directed attention to the portion of the brain, it has received a very large amount of attention from pathologists, and especially from microscopical pathologists. But no writer, perhaps, has so plainly asserted the morbid condition of this portion of the brain in general paresis as Dr. Ernst Salomon, in this Journal. The pathology of the disease, as it may be read there, is, as it were, settled and determined; nevertheless, my friend must allow me to submit his article to a little critical examination, as it is also my intention to submit the author's facts whom he quotes to the test of the microscope. Dr. Salomon writes—"The honour of having demonstrated the anatomical changes in paresifying mental disease belongs to the Vienna school (Wedl, Rokitansky)."

"K. Wedl has in every case of general paresis demonstrated an hypertrophy of connective tissue on the small arteries and veins in the pia mater and cortical portion of the brain" (p. 377, No. XLIII, 'Journal of Mental Science').

I have Wedl's 'Beiträge zur Pathologie der Blutgefässe,' Wien, 1859, before me, which is the treatise Dr. Salomon refers to and quotes, and I cannot find a single word about general paresis under that or any other name alluded to. The opening words are—"Die Atrophie der Gehirnrinde ist, wie bekannt, insbesondere an mit Blödsinn behafteten Individuen vertreten; Sie tritt um so prägnanter bei den blödsinnigen Griesen hervor," which appears in English to be—"Atrophy of the cortical substance of the brain, it is known, occurs especially in individuals affected with imbecility, and is particularly observable in the imbecility of the aged." The fact actually being that the Germans do not separate the cases of imbecility with paralysis from that without, and do not treat general paresis as a distinct disease. Dr. Salomon continues quoting still from Wedl:—"On the outer wall of the vessel is a hyaline, imperfect layer of connective tissue, studded with oblong and rounded nuclei. This layer of connective tissue, projecting over a greater or less extent of the vessel, undergoes, with the nuclei occurring in it, in the direction from within outwards (from the periphery of the vessel towards its centres), a fibrillar change." This passage appears to be quoted from the following:—"An den peripheren Schichten dieser hyalinen Anlagerungen scheinen solche Stellen, wo schon ein fibrillärer Zerfall in einem kleinen Bezirk eingetreten ist, darauf hinzuweisen, dass die fibrilläre Umwandlung der glashellen Schichten mit ihnen Kernen von der Peripherie gegen die Lichtung hin erfolge." If what takes place 'in the pia mater and cortical portion of the brain' in general paresis be described on the authority of this passage, it is somewhat singular that Dr. Salomon should not have read the first part of the paragraph from which the above words were taken. The paragraph commences thus:—"A very favorable place to follow out the hypertrophy of the walls of the vessels, and their transformation into variously swollen cellular fibres, is the walls of the ventricles in chronic hydrocephalus;" that is, the appearance is said to occur, not in paresis, but hydrocephalus; and not in the cortical substance of the convolutions, but in the walls of the ventricles. So that, so far from Wedl proving a lesion to be special to paresis, he proves the contrary, and that the lesion in question is at least common to other cerebral diseases and to other portions of the brain.

Wedl's treatise is not on the state of the brain or insanity at all, but on the blood-vessels. The argument of the treatise may be thus briefly stated:—That the small blood-vessels and capillaries generally, play an important part in various morbid processes, that a prolification of cells takes place on the walls, and which, variously modified, are concerned in the formation of pus, cancer, tubercle, &c. Or, by the shrivelling and subsequent atrophy of the cells, an obliteration, by shrinking, of the vessel itself, occurs, and a consequent conversion of the obliterated vessel into bands or fibres of connective tissue; that the atrophy of the capillaries is followed by a defective nutrition of the part concerned.

By the aid of Wedl's very excellent treatise, I have myself submitted a number of cerebral vessels to microscopical examination, and have compared the state of the vessels in persons dying sane, and in various forms of mental disease, with the vessels of those dying by general paresis. To examine the capillaries, the best mode appears to be to take about a cubic inch of the cerebral substance from the summit of the brain, together with its investing membranes, and carefully to submit it to the action of a stream of water until the whole of the cerebral matter is removed. It is necessary to be careful to use filtered water only after the membranes are completely washed; they may be stained with a colouring matter, but my own preparations are immersed in a strong solution of litmus, and are preserved in Goadby's B. Fluid, which is a strong solution of salt in water. The vessels will be completely coloured and fit for examination on the second day. The following account of the various morbid appearances found in the capillaries is given by M. Wedl:

1. A wavy, longitudinal marking in the structureless connective tissue of the walls of the vessels, and which he considers to be due to a shrivelling of the nuclei, and which ultimately results in an obliteration of the passage of the vessel. This appearance I have not recognised in my examinations of the brain.

2. He notices the appearance of fine, transverse ridges, which at first are only visible next to the margin of the vessel, but which subsequently can be traced further towards the axis, and at the same time the wrinkling becomes more irregular and assumes a brownish colour. This appearance is exhibited in fig. 3, *b*, from one of my own cases of general paresis. He believes these transverse markings proceed from the shortening of the vessels. To my mind, the contrary appears more probable, and that the shortening is produced by the contraction of the substance which he names hyaline deposit.

3. Besides the atrophy described above (§ 1), he has met with hypertrophy of the walls in different forms of chronic mental disease, forming a bulging or bump-like hypertrophy of the walls, and which does not correspond to aneurismal enlargements of the channels; and he believes he has seen these elevations that have become transformed into a finely striped mass of connective tissue. This appearance is also described by Rokitansky,* who gives two figures of the appearance, copied and reduced in fig. 1. He describes this appearance thus:—Anomalies of the calibres of vessels are met with in two forms—1, as a simple enlargement, with or without elonga-

* 'Lehrbuch der Pathol. Anat.,' B. ii, s. 381.

tion, with winding, twisting, or hank-like doubling (fig. 1, *a*), more common in the skin and mucous membranes; and, 2, as a circumscribed, spindle-shaped, one-sided, sacculated, bulging of the vessels, as aneurisms in the small and capillary arteries and

Fig. 1.

Fig. 2.

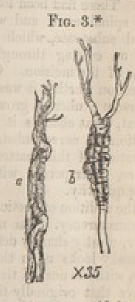
Fig. 1. Reduced from Rokitansky.
Fig. 2. From preparation in possession of the author.

varices in the veins (fig. 1, *b*); and he describes the latter to be met with in the brain in old encephalitic centres. In my own earlier examinations I believed I had detected this aneurismal enlargement or bump-like swelling of the vessel, and sketched several such appearances from two cases of general paresis, in one of which cases the preparation has been saved, and is the specimen from which fig. 2 is copied, and which, in the bare outline, will be found to be very similar to fig. 1 from Rokitansky; but a more thorough examination brought to light the real nature of the preparation, and showed that the appearance was due to a varicosity of the vessel rather than to an aneurismal condition. The verification of the convolutions of the vessel, enclosed in a somewhat dense sheath of homogeneous membrane, beset with earthy particles, needs the strong light of the achromatic condenser, and ¼-inch object-glass to render its definition perfect. In nearly every case of general paresis since examined by me there has been discovered some disposition towards a similar condition.

4. Wedl also describes a layer of hyaline embryonic connective tissue on the outer walls of the little arteries and veins, beset with oblong and grouped nuclei, which project in the form of nobs, and which he considers are due to hypertrophy of the connective tissue. "These hyaline deposits of the little arteries and veins amount to

one fourth, one half, and one third of the transverse diameter of the vessel, or at times exceed its diameter altogether. They occasionally form the nidus of olein, of reddish-yellow, brown-red or deep-yellow grains, of different sizes, and amorphous calcareous salts." This appearance is familiar to me in my own preparations, and is shown in fig. 3, *a*, taken from a patient who died of general paresis.

Fig. 3.*



5. Wedl also examined into the condition of the blood-vessels, especially in reference to the prolification of cells in the walls. The consideration of the question would lead me too far from my present argument, which is whether there exist essential histological differences in the minute anatomy of general paresis and other forms of mental disease.

There is to be found, in fact, a slight or apparent difference between the views propounded by Wedl and those of Rokitansky, and which the former thus alludes to, and endeavours to avoid by saying that, though he considers that the capillaries are converted into fibrous cords, that this does not necessarily imply that such is the only mode by which an excess of connective tissue occurs:

"Um etwaigen Missverständnissen vorzubeugen, erlaube ich mir gleich hier zu bemerken, dass aus dem Gesagten Keineswegs noch mit Bestimmtheit sich folgern lässt, die bindegewebigen Wucherungen überhaupt, also auch die interstitiellen nähmen stets und nur ihren Ausgangspunkt von den Gefässwandungen."

My own examinations of the capillaries in about twenty cases of insanity, and of which seven were from patients who died of general paresis, lead me to the conclusion that the capillaries of the cortical substance are more or less diseased in every case of general paresis. I do not find, however, that the amount of alteration bears any relation to the date, degree of imbecility, or impaired motility; nor have I detected any correspondence between the diseased condition and the etiology; but, on the other hand, I have not found the same amount of abnormal appearance in the capillaries of the other cases. My own observations will be better understood if postponed until the views of Rokitansky, in the treatise to which Dr. Salomon alludes, have been considered. Rokitansky's treatise is entitled 'Ueber Bindegewebs-Wucherung im Nervensystem,' or, 'On the

* Fig. 3. From preparations in possession of the author.

Exuberance or Overgrowth of the Connective Tissue in the Nervous System.' Like the treatise of Wedl it was a contribution read before the Academy of Sciences of Vienna, and it was written, the author says, to bring together subjects which, from the plan of his large treatise ('Lehrbuch der Pathol. Anat.'), were necessarily disjoined. There had been long known to him, he says, an appearance in the spinal cord, and which he had described, consisting of a softened substance, which is homogeneous in its composition, and which, on cutting through the cord, appears to run over the margins of the incision. On examining this substance, there arose the question whether it was to be considered (1) as a new product, or (2) as an exuberant growth ('Wucherung') of the normal tissues; and next, what changes it undergoes, and what is its relation to the induration of nerve substance. He states that the microscopical examination of this matter shows it to consist of a ropy, formless moisture, interspersed with little granular, glistening nuclei, in varying quantity.

On the addition of acetic acid, the substance becomes imperceptible from transparency. The naked cell-nuclei, in an unexpectedly great number, mostly sharply defined, become clearly distinguishable; and Rokitansky looks upon this matter as analogous, if not identical in nature, with the normal tissue as found in the ependyma in children. He says that originally the whole nervous centres are, as it were, developed in, and held together by, a similar or connecting mass, which is continuous throughout the nervous centres, and that the ependyma in the matured texture of the brain is nothing more than this connecting medium coming out on the free surfaces, outside and in. This connective tissue, according to Rokitansky, undergoes various morbid changes, viz.—1, an hypertrophy or overgrowth; it may then gradually harden, and finally undergo transformation into fibrous connective tissue.

When hypertrophy of connective tissue occurs in the brain, Rokitansky says that the essential elements, or other normal elements, of the cerebral matter, as ganglion-cells, vessels, &c., are thrust apart or separated by the interposing substance. "*In the grey substance the ganglion-cells appear inflated, their continuations are undoubtedly torn, and the nerve-tubes penetrating the grey substance*" are destroyed. The substance in question undergoes a transformation into that of a fibrous connective tissue. It loses its hyaline quality, and becomes of a greyish-white; and it appears as very fine, sometimes softer, sometimes stiffer, filaments, which cross each other in the most variable directions. Occasionally a still further transformation of this substance takes place, and it becomes a stiff, greyish-yellow mass, and which is usually circumscribed in extent.

In connection with the hypertrophied tissue is found amyloid corpuscles, turned blue by iodine. Bodies resembling these, but rendered brown only by iodine, which he calls colloid corpuscles, and here and there a fatty or earthy granular, aggregate and agglomerate, fat-granules and incrustation-cells. These Rokitansky believes proceed from a retrograde metamorphosis of the nerve elements.

The process described occurs in various forms of Nerve-disease, in the brain, spinal cord, or nerves, at times in circumscribed spots, at times more widely or even universally diffused. It may commence in a small focus, and spread; it occurs as an acute or slowly invading disease. Rokitansky believes that it is *not* to be looked upon as *an inflammatory affection*, since exudation and its elements are absent, as well as extravasations in any quantity. He writes—"The forms of the disease, of which the overgrowth of the cellular tissue of the nerve-centres must be considered as the essential anatomical element, are very manifold." With respect to his investigations particularly directed to cases of general paresis, with the 'monomanie des grandeurs," Rokitansky found that the changes stand in intimate relation to the pia mater, and occur usually and primarily in the convex surface of the brain. He says that he has found frequently that the white layer interspersed between the ganglion substance has disappeared. The microscopical examination exhibits appearances which differ according to the stage of the disease, and are—(*a*) an unusual quantity of connective tissue, forming the bed for the nervous elements, and which is sticky and tenacious, give the gray matter a loose or succulent character. In older cases it becomes stiffer. Lastly, it becomes fibrous, and retracts, causing adhesion of the pia mater. (*b*) The nerve-tubules he found to be varicose, broken, and the pieces are formed of various forms—club-form, pestle-shaped, rings, &c. The ganglion-cells appear distinctly inflated. (*c*) But with the above there are seen colloid and amyloid bodies.

The changes in the pia mater consist in adhesion to the surface of the brain, in varicosity of the veins, in their winding, tortuous, coil-like, twisted course, and in aneurismal dilatation of the little arteries.

My own examinations have only as yet extended to the capillaries, but I have, of course, incidentally examined the brain substance, but at present must confine myself entirely to the vessels.* There appears to be some amount of tortuosity in the capillaries in every case of general paresis. This tortuosity in places amounts to a simple, sharp curve or twist; in places to a kinking of the vessel (fig. 3, *a*); in others to more complex twisting, until it forms, in fact, little knots of varicose vessels of very complicated kind (fig. 2). I have not found

* The preparations illustrative of these conditions I shall be very happy to show to any member of the Association.

this appearance in any other form of mental disease, but it is described as existing in other cases both by Rokitansky and Wedl.

I have never been able to convince myself of the existence of anything like aneurismal dilation. Can it be that these little knots of varicose vessels have been mistaken, as they were at first by myself, for aneurismal enlargement? It must be borne in mind that the two are very different conditions pathologically, and a multiplicity of aneurisms confined to one set of capillaries is not a morbid state that analogy of other morbid states would lead us to expect. Varices of vessels confined to circumscribed localities are at least more common.

Another appearance which my preparations show is what is called a hyaline deposit around the capillaries (fig. 3, *a* and *b*,) fitting, as it were, more or less closely to the vessel, in greater or less degree of transparency and extent, in some cases approaching a brownish hue and marked by transverse lines like commencing contractions. This appearance I have found more common in cases of general paresis, but in one case of epileptic mania a corresponding appearance was present. The character of the surrounding substance was somewhat different in character.

The presence of this hyaline around the capillaries, the frequent occurrence of fibres traversing the preparations of cortical substance of general paresis appear to be due to an excess of connective-tissue fibres in these cases. Whether this excess is from what Rokitansky calls 'Wucherung,' or overgrowth of the original connective medium, or is thrown out by the capillaries, or is formed conjointly by both, is and must probably remain hypothetical; but excess of connective tissue, I think, can be demonstrated.

To me it appears highly probable that the hypothesis of Rokitansky is correct, as well as that of Wedl, relative to the formation of connective tissue from a material thrown out by the capillaries, and that in the first stage this material is hyaline; that it afterwards contracts; that in contracting it throws the capillary into bends or kinks, as in fig. 3, *a*; that as it goes on contracting it becomes less hyaline, more fibrous, and at length like a sheath; that if converted into fibres, it has no share in the formation of the innumerable fibres that can be seen lacing and interlacing across the field when a portion of gray matter of a paretic brain is under the microscope. It appears more probable that these are formed as Rokitansky suggests.

With respect to the essential nature of this morbid substance, Rokitansky says it is not to be considered as a heterologous formation, nor a product of inflammation.

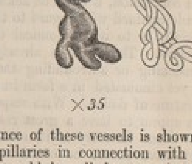
Its relation to the phenomena of general paresis cannot yet, in my opinion, be clearly defined. The condition is not confined to general paresis. Rokitansky, as already described, met with it in other

forms of disease. It can, therefore, only be the essential morbid change in paresis by occupying a particular seat, as the cortical surface of the brain, or by a special rate of progress, as by being chronic in one disease and acute in another. The peculiar relation of the exuberant development of the connective tissue, and the condition of the capillaries and small vessels, is another point on which more information is desirable.

Bearing in mind this variation of the seat of the affection and rapidity of morbid processes, it may be asked whether those allied affections which have been alluded to in previous pages of this communication, under the name of pseudo-forms and several distinct forms, may not be nearly allied, and vary in their symptoms by varying in the seat and activity of the morbid growth.

A case having certain characters of general paresis, yet differing widely from the typical cases, lately occurred to me, and in which the following appearances were found after death:—On cutting across the right crus cerebri, it was found to be evenly spotted with red points of the size of pins' heads. On opening the cavity of the fourth ventricle a growth was found to fill up the whole of the right side of the cavity, and the substance of the cerebellum was pressed upon by this growth. It had the external characters of encephaloid cancer. Microscopically, it was found to consist of a homogeneous, viscid substance, interspersed with nucleated, angular cells, resembling epithelium-scales, but of small size; but scattered through the substance were numerous capillaries arranged in loops, surrounded and imbedded with this ropy matter. These vessels were distended with blood; they appeared to be all of uniform size, and without branches. Some of the loops were simple, some were very short, but they appeared at the periphery of the morbid growth to terminate in complicated hanks, each hank being closely surrounded with a layer of the viscid substance. The appearance of these vessels is shown in fig. 4. This disposition of the capillaries in connection with this growth, which in ordinary language would be called cancer, is interesting in connection with the varicosity of the capillary vessels in the exuberance of connective tissue in general paresis.

FIG. 4.*



×35

And the symptoms are no less interesting in relation to the question

* Fig. 4. Capillaries from a case of so-called cancer of the cerebellum.

of pseudo-forms of paretic disease. The patient was reported to be labouring under a second attack of insanity. On this subject there was doubt, however. She had been insane, at all events, above nine years before any paralytic symptoms occurred. The difficulty of motion commenced gradually in the lower extremities, and gradually increased, and she died about seven months after. Her tongue was slightly affected. She had slight difficulty in pronouncing the labials. The memory failed towards the last, but the mind improved in other respects. There was no *monomanie des grandeurs*. There was no increase in the difficulty of articulation at the last, and no difficulty of swallowing. The lower limbs were drawn up about three or four days prior to death. So far as the difficulty of movement in the limbs, the slight mumbling articulation, and some amount of imbecility, the case might be considered to belong to the category of paresis. But in investigating the pathology of general paresis, it is obvious that such cases should be separated from cases of truer type; but the growth, though circumscribed and more obvious than the exuberance described by Rokitansky in the cortical substance of the hemispheres, is apparently not widely different from it in nature; and if so—if this growth has an affinity to the exuberant growth of paresis—the symptoms were modified by its circumscribed position, and by its rapidity of development, probably. On the other hand, if such growths really are allied to cancerous affections, then the affection described by Rokitansky, 'Bindegewebs-Wucherung,' and which, he says, is not the product of inflammation, and not a heterologous formation, may be nearer to cancerous or allied diseases; and the modern views in respect to the latter affections renders such approximation in kind between these diseases less improbable than was formerly supposed.

In conclusion, it must be acknowledged that there is much which is undetermined with regard to the pathology of general paresis, and especially as to its anatomical character and diagnosis from allied affections. The labours already expended upon the subject are approaching or surrounding the truth, probably, but the truth is not yet eliminated in a form in which we can consider it free from admixture of doubt. With respect to the symptomatology, certain cases appear to have a great resemblance to each other; still many cases occur in every asylum with admixture of paretic symptoms, which have yet to be clearly explained—for example, cases complicated with epilepsy, cases which recover, those clearly resulting from excessive drink, besides those called chronic alcoholism; and explanations are wanting why, in some cases, the disease commences in the motor and in other cases with the mental symptoms. The microscopical examination of the brain substance itself, both of the cerebrum and cerebellum and cord, is a work which requires to be

more fully prosecuted, and is obviously one which must yield important results. I am enabled to assert this from the progress I have already made, and I am happy to say I have enlisted my friend Dr. W. H. Dickinson, of St. George's Hospital, to assist me in prosecuting an inquiry into this part of the subject.

THE NATURE

OF SO-CALLED

"PARASITES" OF THE SKIN.

BY

W. TILBURY FOX, M.D.Lond.,

UNIVERSITY MEDICAL SCHOLAR; PHYSICIAN TO THE FARRINGDON GENERAL DISPENSARY.

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THE NATURE OF SO-CALLED "PARASITES" OF THE SKIN.

In the *British and Foreign Medico-Chirurgical Review* for January 1864, is an elaborate article by Mr. Erasmus Wilson, *On the Phytopathology of the Skin and Nosophytodermata, the so-called Parasitic Affections of the Skin*, in which an attempt is made to overthrow the almost universally accepted view of modern authorities, in regard to the nature of "parasitic" bodies. The vast influence which the name of Mr. Wilson exercises in dermatological matters, must alone guarantee an acceptance of the doctrines put forth in the essay referred to, by those not well versed in the special literature of skin-diseases. Now, of late years, several questions relating to parasitic diseases have been centres of the most opposite opinions. Are the "parasites" the result of spontaneous generation? Are they produced by a transformation of the molecules of a higher into a lower state of life? Are they vegetable in any degree in their nature? Are they the *vera causa* of disease, or only secondary products? In my work on *Parasitic Diseases*, an attempt has been made to satisfactorily determine most of these queries, but no discussion is contained therein touching the exact nature of so-called parasites, because almost every authority admits absolutely their *vegetable* nature. The essay of Mr. Wilson necessitates a detailed examination of the question; for, indeed, if the more prevalent view be erroneous, and that of Mr. Wilson correct, the whole of our pathology and treatment is bad in the extreme.

Speaking generally, the article is a representation of the views of MM. Robin, Bazin, and Hardy. The original matter relates more particularly to the origin

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and nature of the parasitic germs; there is scarcely more than a passing notice of the question pressing now-a-days most strongly for solution: viz., the *identity* or *relation* of parasites, a part of the subject which contains the most telling arguments *against* the doctrine advanced by Mr. Wilson.

The present remarks will be directed especially to the examination of the opinion advanced by Mr. Wilson, touching the nature of the so-called parasites. I may first call attention to the very elaborate and complicated nomenclature introduced into the article, forming a total sufficient to bewilder and reduce to despair not only the student but the more learned practitioner. The following may be quoted:—Phytopathology; Nosophytodermata; Phytiform; Porrigophyton; Aphthophyton; Mentagrophyton; Porrigo tonsurans; Porrigo decalvans; Alopecia areata; Phytodermic; Chromatogenesis; Epidermophyton; Mucedinales; Dermophyton; Mycodermis; Trichosis furfuracea tonsurans; Tinea pelada; Tinea mentagrophytes; Furfuræ dermophyticæ; Lichen annulatus serpiginosus; Herpes circinatus pustulosus; Herpes esthiomenos; Pelada decalvans; Tinea achromatosa; Tinea pelada simplex; Area alopeciata; Trichosis area ophiasis; Dyschromatogenous; Furfuræ parasiticæ; Dermopathology; Trichosis maxillaris; Trichosis corporis seu lichen annulatus; Phyticides.

It is a matter of no denial, that these "hard names" are very obstructive to the advance of knowledge. Take one general term: be it porrigo or tinea, and then particularise each variety by appropriate additions: Tinea favosa; Tinea tonsurans; Tinea decalvans; Tinea circinata; Tinea sycosis; Tinea versicolor; and the result will be materially the better, in that we may reject, *in toto*, all sources of confusion in nomenclature. Why cannot we use the term Parasitic Diseases instead of Nosophytodermata? Indeed, if the latter be not produced by "vegetable growths" then is the term Nosophytodermata in every way incorrect. It is much more desirable to employ names which are "easy to read and write," and which "convey quite as correct a notion of the characters of the disease," even "in preference to the more lofty-sounding" ones.

It is a fair criticism, to say that the article "Phy-

topathology" in the *British and Foreign Medico-Chirurgical Review*, does not deal with the subject in a liberal manner. The arguments contained in it, cannot be fairly said to be a "total" of *pros* and *cons*; indeed, the data which form the basis upon which the vegetable nature of parasites rests, are not refuted—not examined. True, the history of their discovery, their outward resemblances, and their microscopic appearances are discussed; but the arguments derivable from analogy, the vital and chemical behaviour of the "parasites," the effect of treatment and the like, are not noticed. Mr. Wilson details very clearly and forcibly the mode in which he conceives the parasitic bodies to be produced by a "granular degeneration" of normal tissues, and refers for corroboration to the instances of the development of "mucus and pus" to be noticed presently; but it seems to me that the whole point has been examined by an anatomical eye and anatomical ideas, without any reference to the *botanical* view of the case. "More than twenty years since," says Mr. Wilson, "after a careful microscopic investigation of the pathological elements of which they are composed, we came to the conclusion, that they resulted from an aberration of cell-formation; that this aberration consisted in the growth and proliferation of the primary granules of which epidermic cells and hair-cells are normally constituted; that this growth and proliferation had the effect of arresting the granules at their embryonic stage, and in the performance of their embryonic functions, and, as a consequence, that the cell-tissue (epidermis and hair) composed of these embryonic granules and imperfectly elaborated cells, was, upon desiccation by the air, dry, spongy, friable and brittle; that, in trichosis, this change alone existed in the hair and epidermis; whereas, in favus, the granules composing the yellow disk around the mouth of the follicles passed through a pustular stage, the consequence of a higher degree of inflammation, and, in their pustular condition, obtained their peculiar yellow colour. We called this morbid alteration of the primary granules of the epidermis and hair-tissue 'granular degeneration', and subsequent experience has not altered our opinion."

As regards the mode of increase and production: "the granules are nucleated, separate or in groups,

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or adherent in moniliform strings of two to four, or five in length. The greater number of the granules are uninuclear; some, however, are binuclear or trinuclear. The binuclear granule is in process of proliferation; the original nucleus has split into two, each moiety has become a separate nucleus, the space between them has increased, a septum has arisen in the interval, and the cell has become oblong—an oblong cell with two nuclei, or rather two independent but adherent cells; cells that may subsequently divide and become separate unities. This is the mode of cell-proliferation." At an early stage, and in near contact with the vital tissues, the tendency is to the formation of granules; but, "removed from the source of nutrition proliferation weakens, the divided cells remain adherent, and either retain their globular and embryonic shape, and give rise to moniliform filaments, or they grow in length at the expense of their contents, and form cylindrical and transparent filaments divided by septa, each intermodial segment representing a single original globular granule or cell." They lapse, in the latter case, "into an irregular and filamentary proliferation, giving rise to an inferior form of organisation neither so complete nor so permanent, and which converts the higher animal organisation into a lower and phytiform organisation—an animal tissue into one which might be likened to a vegetable tissue." These quotations give us as the source of the so-called fungus-elements, the normal tissues (epidermic granules); the nature of the disease pathologically as a "granular degeneration;" the mode of increase by the division of the nuclei of the cells, and the secondary division of the cell itself; the formation of so-called mycelium by the division of the nuclei, but the non-separation of the binucleated cell into separate unities. These stages are best seen in favus. The granules are globular, uninucleated, bi- and trinucleated; the mycelial forms are moniliform and opaque, cylindrical and transparent, with a branched and ramified filament. "In the case of the trinuclear cell a bifurcation is effected, and the proliferation of each part of the tissue-cell lays the foundation of a branched and phytiform growth." The peculiarity of favus "is due to a pustular complication;" the layer of the favous mass next the basement membrane of the derma is

made up of pus-globules; "these pus-globules contain from four to seven or eight well-formed nuclei; and these nuclei, on their escape from the cell-membrane of the pus-globule, become the nucleated granules which are the chief constituent of the pathological product." The moniliform thread is produced by the coalescence of these escaped nuclei. We have, then, a further proposition to notice; that in favus the "phytiform" elements are derived from the nuclei of pus-cells. Mr. Wilson interprets the term "granular degeneration," by "the idea of an arrest of development of the cell-tissue of the epidermis at its embryonic stage, and the production of a tissue constructed of crude and imperfect materials, which represent an earlier period of cell-generation than that which Nature intended, and which, in consequence, is truly in a state of degeneration from the perfect type."

Now, it is impossible to overrate the immense importance of the opinions contained in the quotations given; for, seeing that they differ in *almost every particular* from the opinions of our great dermatologists and botanists, a considerable check must be given to the advancement of the study of Parasitic Diseases, until the conflicting opinions of high authorities are harmonised, or the one or the other is shewn to be untenable. The whole matter rests upon the solution of two questions. The one is, Are the so-called parasites vegetable in their nature? The other is, Can an animal by a retrograde metamorphosis ever become converted into vegetable tissue? Then comes the subsidiary question: What are the effects of the growth of parasites?

First, then: What are the grounds upon which the opinion of the vegetable nature of parasites rests? Speaking generally, we find that the existence of vegetable growths is very general in the hard external covering of living beings; and not only this, but there is a complete similarity between the unicellular plants found upon man, and those found on animals. They have been observed, especially by Kölliker, in sponges, foraminifera, corals, bivalves, brachiopods, gasteropods, annelids, cirrhipeds, fish, etc. A very familiar instance is that of the silkworm and caterpillar disease of parasitic nature.

We should be led, then, to *expect* the occurrence of

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vegetable parasites upon the outer covering of man; and the attributes possessed by so-called parasites are sufficiently distinctive of vegetable bodies: they are, briefly, *structural*, *chemical*, and *vital*.

a. *Structural*. We are able to distinguish the presence of cellulose externally, and internally the primordial utricle coloured by iodine; also the *tubed* mycelial form and fructification; the latter being unrepresented in animal structures.

b. *Chemical*. Ether, chloroform, and spirit of wine render epithelial tissues transparent, and dissolve all fatty substances; whilst vegetable parasites remain unchanged. Ammonia dissolves animal products, *ex. gr.*, pus, puriform secretion, "crusts, etc., converting them into a gelatinous mass"; and caustic potash behaves in like manner.

c. *Vital*. These are by far the most important to notice here. Something may be learnt from a consideration of the localities in which parasites grow, as follows; on the skin generally; in depressions of the derma (follicles); on the epithelial tissues, in the case of the Madura foot or podelkoma; a wound is often followed by the development in it of fungus elements; in the stomach, intestines (hence in the stools); in the œsophagus, vagina, uterus, pleuræ, cavities in the lungs, urine, the wax of the ear, etc. Now, in the vast majority of cases, it is clear that the external air has free access to those situations in which fungi are wont to occur. The exceptional cases admit of very considerable doubt. For example, in the interior of the egg a fungus has been found, but has been supposed to obtain an entrance before the formation of the shell, when there can be no difficulty in accounting for its presence through the medium of the external air. The fluid of the ventricles of the brain, the kidney, and the bladder, have been stated as places where the elements of a fungus may spring up without communication with the exterior. The evidence, however, is open to grave negation. It is quite possible that the development, rapid as it has been, has taken place after the removal from the body or the exposure to the air of the fluids in which it is found. The most notable case of the kind is recorded by Dr. Begbie in the *Edinburgh Medical Journal* for April 1856, in which sarcinæ were found in fresh urine, immediately after micturition, upon two occa-

sions. Can air enter the bladder from without? Another explanation has been offered, by supposing the "germs" of the entophyte to be taken up by the blood, and deposited in the kidney or bladder, as the case may be; reasoning from analogy, it appears most likely that the "germs" are derived *ab externo* in some way as yet unexplained. At any rate, we may reasonably conclude that, in the great majority of cases, there is the greatest facility for the introduction of parasitic elements from without; and that the occurrence of parasites in certain internal parts of the body directly militates against the theory of Mr. Wilson, inasmuch as their presence is unaccompanied by any change of tissue, especially such as would lead us to imagine anything like "granular degeneration" of the epithelial linings. To argue in this case from a narrow limit of observation, *ex. gr.*, the parasitic tineæ, must inevitably lead to error and misinterpretation.

The argument which determines the whole question at once is the fact that parasites (or Mr. Wilson's "granular degeneration") will grow when removed from the influence of living tissues, and away from the influence of the blood—a property which no one will accord to animal tissue. The most casual experiment will convince any one of the truth of this assertion. If a piece of favous matter, a hair from tonsurans or "herpes circinatus", be "put up" and kept in a warm place, in a short time the *growth* of the fungus will be noticed; not so that of the animal tissues present. The stromal (nuclear) will develope into the sporular form; the sporules will increase in size, join together, bud, or produce mycelium. I have seen in the trichophyton a most luxuriant crop of mycelial threads sprout away from a diseased hair, while the sporules in the interior became chained and moniliform, while not a particle of fungus could be found in any other part of the field, to suggest an origin from any other source. These artificial germinations are not always successful, and require care in their manipulation; in them we see another very important argument militating against the "granular" theory, and confirming in strong terms the vegetable nature of parasites—viz., the pathological tendencies. After a time, these artificial preparations exhibit a great contrast. The spores become chained, double-

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contoured, large, forming a mass of slightly squared cells, chained and linked in all directions, mostly in the axis of the least pressure—viz., longitudinally, or rather parallel to the long axis of the hair; mycelial threads sprout away from the side of the latter, and now and again attempts at fructification are observed; but, inasmuch as the influence of the external air is withdrawn, it cannot be perfected. In contrast to this state of growth is the fatty degeneration of the animal structures—hair, epithelial cells, and the like. I remember to have shown some of my friends a most charming specimen of the kind in perfect preservation (a hair loaded with the trichophyton tonsurans), in which these changes were as marked as possible; the fibres of the hair had degenerated, and their place was supplied by beautiful tufts of crystallised fatty matter; while the fungus itself was freely growing and encroaching upon the space occupied by the hair-fibres. Originally, the shaft of the hair was perfect in its structure, only freely infiltrated with sporules. A prettier object for the polariscope could not be imagined.

Now, if the parasite were a lower form of animal life, a degeneration of the normal structures, surely it should first of all undergo that kind of degeneration so characteristic and cardinal in, as they may be called, dead or dying tissues of the animal body; whereas, in the case in point, we find a positive divergence, a development of the vegetable and dissolution of the animal tissue. It avails nothing to argue here, that there is a conversion of the one into the other; because, leaving out of view the different kind of metamorphosis going on, there are no transitional stages; and the perfectly formed structure of the hair disintegrates by a chemical process, its vital life being wholly null and void; and, according to Mr. Wilson's theory, the "granular degeneration" is a vital process, of course. The only vital process present is the growth of the parasitic vegetation. Hence there is a further point to notice. The change in the animal structures is a *chemical*, that in the parasitic a *vital* one in addition—a distinctive difference, which needs no further consideration. The chemical destruction of the animal, no doubt, helps the development of the vegetable; but the one is not produced by a transformation or modification of the molecules of the

other. The same kind of independent existence of parasites is seen in those cases in which the shaft of the hair is retained in the follicle, while its root is totally disconnected with the formative process. The hair is in this case, to all intents and purposes, a dead structure, yet the parasitic vegetation luxuriates; and other cases might be quoted. The existence of budding is another feature of distinctive significance as to the vegetable nature of the parasites. This will be referred to again.

The occurrence of an union of cells as an active process may be mentioned. This is a fact which every one will admit. Hebra, Mr. Wilson, and others seem to recognise, as the universal mode of the production of sporules, the constriction of filaments, and separation of the constricted portions, as well as the bidivision of free cells. This is surely an error of observation. The sporules are primary in point of existence, therefore cannot be formed by division of the mycelial cells. Besides, the larger are seen to be produced by the enlargement of the smaller cells. In the case of the torula, this is seen to an extreme degree in its endogenous growth. Saving in the fructification, which is rare in human epiphytes, the most usual process is an increase by endogenous formation, and also the formation of the mycelium by a union of cells (with superadded budding); and in the mycelium the same endogenous growth obtains. Now, nothing of this complete kind exists in the epithelial tissues: endogenous growth, yes, but not a true junction and union of cells. I refer now to the epithelial tissues only, which are those concerned in the discussion.

Parasitic disease can undoubtedly be produced by the introduction of the germs from without, provided there exist a suitable soil. The experiments of various observers will occur to the memory of most readers. In accordance with all that is known of fungi generally, it must be accepted as certain that vegetable growths arise in the case of "porrigo", of favus, and such like, "as they do if a piece of melon or a bit of cheese, not over dry, be placed in a cupboard"; that is to say, in accordance with the same general laws; or, in other words, they never flourish upon "*healthy*" surfaces, though it is difficult to define clearly the exact state of pabulum by external manifestations;

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but that some favourable condition of soil, some deviation of the nutritive process, exists, must be admitted. Well, then, introduce the sporules of a fungus to a person so nutritioned, and parasitic disease will result. Does not the contagious character of tinea make a dead stand against the acceptance by us of the theory of "granular degeneration"? Mr. Wilson states that, in a certain sense, "mucus may be viewed as a *parasite* receiving nutriment from the body, but not shape, nor claim to vitality"; and adds, in a foot-note: "In this sense, we are willing to accord to the nosophytodermata the title which has been assumed for them of parasitic diseases, but not as organisms originating from without, and intruding upon the tissues of man, as the phytopathologists claim." Yet he does not notice the bearings, upon this question, of artificial inoculation and contagion. It has been pretty surely shown that, in the instance of Madura foot, which presents a larger amount of fungus than any other disease, the germs are derived through wounds in the feet; and it may not be uninteresting to observe here, that Mr. Wilson's theory could not explain the development of the chionyphe Carteri in the carious bones of the foot. Looking for a moment to the applicability of the word parasite to the case of mucus (pus), these latter have most special and useful functions to perform, without which nature would suffer very materially. The term parasite, as given to them, leads one to form by far too low an estimate of their nature and worth, and detracts from the beauty and perfectness of conservative nutrition.

The effects of treatment are worthy of mention.

In the tineæ, if the parasite be destroyed, a cure is effected without the use of any internal remedies. It is so in herpes circinatus, in many cases of tinea tonsurans, and in pityriasis versicolor, for instance. Depilation acts in the same way by the removal of the parasite in part, and more especially by enabling us to reach the fungous elements more easily with parasiticides. Mr. Wilson admits that depilation "disposes to the cure of the local disease"; and adds: "But we do and must disbelieve that the removal of the fungus is the proper explanation of the cure." It is partly by removal, and partly by affording facility of access to the fungus; that is the true *modus operandi* of the operation. "We see,"

says Mr. Wilson, "in depilation a stimulant, and a valuable stimulant," etc.; and "we have been led to regard avulsion as one of the best, indeed, our only reliable remedy, for producing *deep stimulation of the cutaneous tissues*, for setting up a new action in the papillæ of the hair; as the only remedy, in fact, by which we can reach successfully the fundus of the hair-follicle." "It sets up a new action, a healthful inflammatory process, in place of a morbid inflammatory process—a process whose natural course is to end in resolution, instead of one whose nature is perpetuity. For morbid cell-germs, it establishes healthy and plastic inflammation, and sometimes healthy suppuration; when, as Bazin declares, the fungus is starved or drowned." Now, in the very worst forms of the disease, the hairs are perfectly loose, and can be even readily combed out; hence avulsion can do nothing here by stimulation, only by removing the sporules. Indeed, if there be a point of practical importance in the treatment of parasitic disease, it is the removal of all "dark stubs", which are quite loose, but which are literally crammed with "germs" of disease. How the mere removal of a hair from its follicle can set up a healthy process, and alter *in toto* the particular form of nutrition upon which depends the morbid cell-genesis, is a problem which would be indeed difficult to prove; it is curious pathology. The depilation is followed by a reparative action, by which the hair is reproduced in integrity, upon the same principle that all local injuries are remedied. "Even Bazin has recourse to avulsion as a stimulant in old cases of mentagra, wherein the hair acts the part of a foreign body, of a thorn, in the skin, and so keeps up irritation". This is an admission that the hair acts as an *irritant*. But a healthy hair does not do so; consequently, the removal of the hair is effected not with the view of *stimulation*. In addition, it creates a free outlet for the retained contents of the follicle. Stimulation is best promoted by anything which increases the supply of blood (in harmony with proper nutrition) to the follicle and its papilla; at least, so teaches pathology. In ophthalmia tarsi, the extraction of the hairs acts in a great degree in like manner, by giving a free outlet for the contents of the inflamed follicles. Depilation, *plus* the use of parasiticides, is the most efficacious plan of treatment; for the least amount of fungus left behind will itself overcome the good effects of avulsion. These considerations are very relevant to the question under consideration.

At page 202 of Mr. Wilson's essay, we read: "We have remarked, that the chief difference between favus and the other forms of phytodermic disease is due to a pustular complication. In fact, we have observed that the layer of the favus-cup, which lies in contact with the basement-membrane, is composed of pus-globules." This is not consonant with general observation; it is rather the exception, according to most observation.

At page 215, we read: "Suppuration of the follicles performs the part of a natural cure of the disease. Bazin emphatically observes, that pus destroys the parasitic fungus; and therefore, in seeking to find it when suppuration has commenced, we must avoid those follicles and those hairs which are bathed with pus." So far, then, there is an evident contradiction. Pus is the great destroyer, and yet the great producer, of the parasitic growth ("granular degeneration"): to avoid which, Mr. Wilson adds: "That kind of inflammation which is productive of normal pus is not the form of inflammation which causes granular degeneration of the cell-tissues of the skin, but, on the contrary, is opposed to it." I dare call this argument pure assumption. My examinations have been carefully made, and have not resulted in determining the existence of the presence of pus and a luxuriating state of fungus; nay, the reverse. Nor does it occur to me to adduce, as a matter of fairness, any fact in support of the existence of a specificity in the attendant inflammation. An abnormal state of nutrition exists, which is seen by the presence in the follicle, in favus especially, of a secretion "possessing a fluid or semifluid state when first formed, and hardening into a kind of paste, which subsequently becomes dry and pulverulent," etc. This is not pus; it is observed in the convalescence from favus, when the true favus-matter has disappeared, and is typified by the "secondary eruptions" which follow the fully developed disease. It is an evidence of the existence of a special pabulum or soil; and, be it observed, does not give origin to the "granules" or parasites, which arise from out their

own proper germs. Pus, then, is often absent; and there is no ground for believing in the existence of a specific kind of inflammation, but in a state of nutrition which, *per se*, does not give origin to parasites. But there is another consideration. It has been clearly shown that there is *great similitude* between the spores of favus (supposed by Mr. Wilson to arise from pus-nuclei) and those of the trichophyton and even oidium and torula, if there be not an identity.

"We can only say that we attach very little weight to the opinion of any man who has the temerity to pretend to establish a diagnosis between favus and trichosis tonsurans, on the more than doubtful differential characters of the achorion and trichophyton, as viewed by the microscope," says Mr. Wilson, in words which happily confirm the opinion advocated by myself in my work on *Parasitic Disease*, and which certainly imply that the "granular" bodies in the two cases have a common origin. How, then, come favus from pus, and the trichophyton from the epidermic granules?

The colour of favus has been attributed to the appropriation by that disease of the colouring principle of pus. Well, it may be. But, if the colour of parasitic vegetations (granular degenerations) be derived from the tissues, how are we to explain the red, golden, and yellow red aspect of the *zooglœa capillorum* discovered by Dr. Aloys Martin (*Med.-Chir. Review*, April 1863) upon the heads of two children ill with typhus? Such is the name given to a parasite which was found attacking the hairs after the usual method of parasitic growth. The colour of favus is, then, no very great argument in favour of the origin of the plant from pus.

It will be well to consider, in the next place, some subsidiary conditions, including also the manner in which proliferation takes place, according to my own observations. And, first, it appears to me that the trinuclear and binuclear character of the spore is not an established fact. It is not uncommon to find a nucleus and granular contents in the cells or sporules; and the arrangement may be bi- or tri-nuclear, as in torula; but this cannot be established as the rule in the parasitic fungi, except in trichophyton, achorion, and tri-sporuloides. In microsporon Audouini, nuclei

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are mostly invisible, and granules are even indistinct. This much is true, that whenever the nuclei are *double*, the cell has a *tendency* to assume the oblong form. The junction and growth of cells produces mycelium, and in the latter cellules are formed by endogenous growth. The sporules do not increase in number, as a general rule, by the process of budding, but by the discharge of cell-contents and the enlargement and growth of the discharged granules (or nucleoli). Dr. Bennett's doctrine appears to me to be the true one, that not division of filaments and cells, but *molecular growth*, is the true developmental process. On the contrary, Dr. Beale, in the controversy upon this point (British Medical Journal for 1863), asserts that cells grow until they reach a certain size, and then divide. But, as Dr. Bennett says, if the molecules divide, "how is it that the filaments can form at all?" Mr. Rainey's observations are confirmatory of Dr. Bennett's view, which is also shown to be applicable to the early formation of the ovum. The best example of the production of sporules by simple molecular growth is seen in the enlargement of the stromal (or nuclear) into the perfect form of fungus. It has never happened to me to see the division of a trinuclear cell, so as to produce a branched mycelial filament, but only a process of sprouting on a limited scale.

"Favus matter and the mucedinales of phytodermata are organic matter arrested in development at the lowest degree of life, the function of reproduction; the sporules are growing organic substance, aborted epidermic granules, the filamentary portion fully formed organic substance, beyond which there is no further growth, the highest and perfected form of development"—are the concluding words of Mr. Wilson (pp. 204-5) upon this part of the subject. It is strange that, in the animal body, we have no analogical instances to prove this view. Reference is made cursorily to the case of mucus and pus; but these two latter differ in every essential particular from the parasites, structurally, chemically, vitally. The increase of pus may take place by "cell-proliferation"; but parasites increase by endogenous growth and union of molecules (mycelium). Pus is a common product; but it never is seen to be "transformed"

into a parasite, except supposedly in favus, where it is often absent.

In the last place, it is absolutely needful to scrutinise the question of the conversion of animal into vegetable tissues. Physiologists instruct us largely upon the laws of growth and reproduction; but deducible from the former is one which is second in importance to none, and it is the *law of limitation*. It is of wide and clear significance; by it tissues preserve their type, though they may deviate to a certain degree in this respect. The law of limitation, it appears to me, forbids us to entertain the conversion of which mention was made a moment since. Let us see, first of all, what Mr. Wilson's opinions are at p. 202 (*loc. cit.*). He says, after their escape, "the nuclei of the pus-globule are adherent to each other, so as to constitute the moniliform strings, etc.; and already, on the first birth of the granules, they are impressed with the type which subsequent development converts into a phytiform tissue": at p. 201, lines 22 and 23, "and which converts the higher animal organisation into a lower and phytiform organisation—an animal tissue into one which might be likened to a vegetable tissue": at line 32, "until we are led to the conclusion that we have before us no longer an animal organism, but a vegetable organism of the fungoid or mucedinous type": at line 45, "a combination which, out of the body and in the free air, would be regarded as a fungoid plant."

Dr. Willshire, some time ago, examined this question; and concluded that "low vegetable organisms are the result, and not the cause, of the maladies they are seen in connection with; and that their development is readily explainable according to well known laws ruling the so-called decomposition of organised matter."

Mr. Wilson, it would appear, thinks that the so-called sporules are altered animal tissues; but, as far as can be learnt, though he calls them phytiform tissue, he does not regard them as of vegetable nature. Then it only remains to examine Dr. Willshire's views, detailed in the *Medical Times* for 1848-49, vol. xix; which remain, I believe, with very little modification, the same in this year 1864. The presence of the oidium in thrush is admitted. Berg, Grüby, and others, taught that this was the sole cause of the disease. "Thrush" (so these writers say) "is the springing up and propagating of a parasitic fungus, the fine threads and fibres of which insert themselves in every direction amid the superior layer of the epithelial scales"; and (according to Grüby especially) even passing into the cells themselves. According to Berg, this generation of the fungoid parasite overwhelms, as it were, the mucous membrane; and is due to a reaction between the albumen and the acid in the mouth, the acid generated by the results of bad feeding, or gastric or other derangement, influencing the buccal secretion. He maintains, also, that local disorder of the buccal lining membrane itself is not to be recognised as the necessary, or even the frequent, antecedent of the true parasitic thrush disorder.

This view was soon refuted by clinical observation, which proved incontestably that "the presence of thrush deposit is preceded by symptoms, not only of a general and constitutional disorder, but of local disease of the mucous lining of the mouth . . . . the plastic deposit the result of a peculiar kind of membranous inflammation . . . . the presence of vegetable parasite, as perfectly irrelevant to the true or only essential pathology of the disorder; and consider its development as readily explainable according to well known laws ruling the so-called decomposition of organised matter." (Willshire).

With a little patience and care, the truth must have been established; the decided but erroneous views of Berg and others were, however, followed by a strong reaction; and pathologists framed a code of laws ruling the decomposition of organised bodies, which, in turn, required modification; at present little cared for, because the subject has fallen into utter neglect. What are the laws, then, *quoad* thrush, by which parasites are governed?

Dr. Willshire says: "Whenever or wherever organic matter, or the cells of vegetable or animal substance previously endowed with a special form of life, are passing into what we term a state of decomposition; a certain amount of the ultimate cells yield up their endowment of vitality to the overwhelming laws of pure chemistry and physics; their chemical elements separating and then re-combining according to these laws, and forming purely chemical compounds subser-

vient to laws of a like nature. But other cells do not surrender up their vitality to any such influences of chemistry and physics; but preserve their great endowment of the spirit of life, and take on afresh a new kind of organic existence, differing from that expressed in the totality of such organism, of which they previously formed a part, or into the formation of whose existence they had before entered. . . . In the production of the fungus, or mould, or new organism, we observe the preservation of the vitality of certain cells, and their continued exemplification of this vitality, in the assumption of a new type of organised existence."

Here we have, then, the opinion of many moderns, that an animal may degenerate into a vegetable tissue; a doctrine which the theory of Mr. Wilson entirely upholds; affirming, as it does, the production of "granular degeneration" (shown to be vegetable in nature, *i. e.*, parasite) from an animal tissue. This extreme doctrine is a gross libel upon the laws of nature; it involves, at the outset, a total abnegation of the existence of a law of limitation; it presents a difficulty, in so far as it asserts that some cells in the decomposition undergo a chemico-physical change, and lose their vitality; but that others do not lose their vitality, and are not made subservient to chemico-physical laws. Yet the same influences and co-existences play upon the two classes in equal force and extent. How can we explain the difference? We know that the air is full of germs of the thrush and other fungi; that these have an existence independent of the body; that they grow upon vegetable structures, etc.; and that it is unnecessary to appeal to any such theory as the conversion of animal into vegetable for their production.

The experiments of M. Pasteur pretty clearly show by negative evidence, notwithstanding the recent experiments of Dr. Wyman, which are open to grave objection (as the reviewer in the *British and Foreign Medico-Chirurgical Review* for January 1864, p. 171, observes), that the origin of germs of low life is the air. We have had a view expressed in one, and a great reaction in the other direction; from which have resulted two absolutely conflicting and contrasting doctrines, and, as in all other instances of the kind, we shall find the truth to be between the two ex-

* China fro

tremes, and to this present pathology is rapidly tending.

Having regard to the law of limitation, as it obtains generally; to the vegetable nature of the parasites; the differential attributes of animal and vegetable; the effects of inoculation (the latter now succeeding, now failing); the experiments of various observers, showing that nutrition is lowered in its standard in cases of parasitic disease, both in man, animals, and vegetables; the experiments of Stilling on frogs; the free existence of the germs in the air; the existence of fungi generally in the hard structures of animals; the independent life of the parasite; the adaptation of certain soils to certain vegetations; the effects of treatment (a combination of local and general remedies succeeding best in tinea); the distinct evidence of the existence of a state of local malnutrition before the appearance of any fungus—*ex.* thrush, potato-disease, and the like—it appears certain that, in all cases of parasitic complication, two conditions are necessary: the presence of a suitable soil, which may or may not be appreciable to the naked or microscopic eye; and the implantation thereon of the germs of a parasite derived *ab externo*. These conditions may vary much in degree; the parasite may take hold upon the surface, and the soal may be too little developed to nourish it; hence its death and disappearance. This explanation holds good equally in tinea, in thrush, in the instances of fungi found in the cavities of tuberculous lungs, the stools of cholera, or the shreddy discharges of muco-enteritis, as in the ordinary "mouldy jam" or oidial vine disease. The doctrine that the tissue of animals can retrograde into vegetable structures like that of spontaneous generation, shocks my mind and offends my reason.

In the case of the caterpillar, the itch in animals, the vine or potato disease, the uredinous disease of cereals, the thrush of infants, the favus of children, it has been incontestably shown that this double action is at work. It is a matter of very decided importance, as concerning the therapeutics of disease. We may treat the disease—favus—locally, and cure it. We may even treat analogous cases generally and cure them, if we can exert a profound influence upon the existing state of nutrition; but the combined

plan of remedial action will save us an immensity of trouble and bring us greater *kudos*.

But then, limiting our observations to those forms of parasitic disease, which the physician is called upon to treat, if there be a peculiar malnutrition present, and a growing parasite, which is the more important to notice? Shall we regard tinea favosa, for example, more deserving the name of malnutrition or of parasitic? We may put it in another way. What is the action of a parasite? Does it exert any special influence?

We leave out of consideration the tendency it has to accelerate "fermentative" action"; and, on careful inquiry, we notice that it has some special action of its own over and above that exerted by the state of soil, and that is, to destroy the formation of hair, and to disintegrate already formed hair. The disease of the hair (and epithelium) is that pathognomonic of a growing fungus; this has been shown in my work on *Parasitic Diseases* (p. 28). General disease, whereby the whole vitality and nourishment of the body is lowered, may be followed by loss of hair generally—atrophy, in fact; but this differs in every essential particular from the active localised *destruction* in parasitic disease.

No disease, except it be accompanied by the growth of a fungus, can produce splitting up of the hairs, atrophy of the bulb, and alopecia. In parasitic disease, other structures may be involved, but not necessarily. Eruption is oftentimes present, but may be evoked by the action of any *irritant;* whereas nothing but the growth of a fungus can produce the damaged hairs, etc., of tinea. Take away the latter, and nothing *diagnostic* of the ravages of the parasite remains. *Per contra*, remove all the *eruptive*, and the parasitic remains in its integrity; the *necessaries* remain, but the *accidentals* are absent. The presence of the fungus increases the local irritation. There is nothing special in that; so do other irritants; but it is not unlikely that the force exerted in its growth and development, which we know belongs in an eminent extent to fungi, may be an additional degree.

At first sight, the behaviour of entophytes (parasites of the mucous surface) appears to contradict that of epiphytes (cutaneous parasites). Remak certainly

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greatly erred when he wrote, "there is a remarkable difference between the pathogenetic relations of the achorion and the fungi growing in the mouth, and probably also in aphthæ," etc. There is the existence of a suitable soil in each case, the presence of a parasite in a state of growth, and certain effects produced by the latter. In the case of aphtha, it amounts to local irritation only; in the disease in which achorion occurs, hairs and hair-follicles exist and become attacked so as to produce peculiar results, in addition to mere local irritation; it is a difference, not of nature, but of extent and degree in the two cases —a difference due to the character of the structure attacked, which alters, to some extent, the plan of treatment in the two cases. In aphtha, it is the alteration of the soil which demands attention with the destruction of the fungus; or, in other words, the removal of an efficient cause of irritation. We do not destroy it with the view of curing the disease; not at all. In favus (achorion disease), we alter the soil. We destroy the parasite with the view of removing a cause of local irritation; but more especially because vast damage and destruction will happen to the hair and hair-follicles unless this be effected. This cannot happen in thrush. There is no contradiction in pathological tendencies; surely not. If it arise in our minds, it must be from a want of correct appreciation; there is perfect harmony in principle, in law, and in result, as far as it goes.

These remarks will at once recall to memory, that parasites have been divided into those which are *true* and those which are *false* (represented, generally speaking, by epiphytes and entophytes), a distinction very important in a practical point of view; but suggestive of a difference in the pathological tendency of the two cases, which cannot be maintained in strict argument. The false parasites would inevitably give rise to disease and destruction of hairs, etc., if the latter existed on the mucous surfaces; but, this not being the case, the growth of entophytes (or false parasites) is comparatively harmless, still the contrast of true and false is by no means inappropriate in a *therapeutical* point of view.

Reference has been freely made to the essay of Mr. Wilson; for it contains doctrines which are diametrically opposed to the more usually accepted view—

the view which guides and directs all our treatment; and upon which is based the most efficacious of all plans of treatment, that by local means. There should be no doubt in the matter; it is one of two things: either we are absolutely wrong or right—absolutely wrong, if the so-called parasites be not vegetable in their nature, or if they be produced by a transformation of animal structures. That neither of these two hypotheses is tenable, it has been the aim of these remarks to show. The view advanced by Mr. Wilson is similar to, indeed a resuscitation of, Unger's idea, broached in 1823, that the uredo (*a parasite*) was nothing more than "broken-up cells, a disruptured and altered condition of certain portions of diseased plants"; an idea which was refuted by the fact of artificial germination.

P.S. I might have gone into the question of the artificial germination of parasites, but this would have opened up too wide a field for the present discussion. The power of parasites (achorion, for instance) to induce fermentation, and the production of fructification typical of ordinary forms of *mould*, may be mentioned as additional arguments in favour of the vegetable nature of parasites. I contented myself with insisting upon their independent vitality. Before concluding, one cannot but express regret that, in the recent number of the *British and Foreign Medico-Chirurgical Review* (April), in a notice of the recent works on skin diseases, this most novel and interesting subject of the relationship of parasites has been almost entirely *depreciated*: the reviewer says, "that, after all, the question is one which concerns the botanist more than the medical man; be the fungi one or many it is the same thing to the practitioner," and the reason given is that the same drug will destroy each fungus with equal facility; but the reviewer states, also, that to reach the parasite is often "a matter of considerable difficulty," tacitly admitting of course the benefit of internal remedies. Now, if the fungi be *different*, there must be *different* soils, and the treatment must be *different—in kind*. If the fungi be identical in nature, then the treatment is a matter of *degree* only; if fungi be different, then ought they to be so many indices to states of economy, states which in time will be fully interpreted. I have

* China fro

no doubt, for example, that when the exact nature of sarcina shall be determined, then we shall possess a tolerable clue to the character of the diseased conditions (the state of stomach derangement) which favour its development,—on the road thereto at any rate,—and the relations and kind of fungus will presently become of inestimable value as guides to treatment. As a writer in the *Popular Science Review* states, in speaking of the variation of fungi, it is of "greatest importance, and throws an entirely new light upon the diagnosis of skin diseases;" and botanists generally share freely in this opinion. No reference is made in the article in question to entophytes, nor to the extremely interesting disease the fungus foot of India, in which the chionyphe Carteri is found, of which full notice is taken in one of the works reviewed, and which is attracting a large share of attentive observation; zooglœa capillorum is omitted, too; and, amongst animal parasites, the chigoe, the œstrus, the filaria, etc.; when, at the same time, Dr. Anderson and I are brought to book for not ranking mollüscum contagiosum as parasitic, because especially "Hardy has discovered the spores of a cryptogamous plant in the sebaceous contents of the shining semi-lucid tumours which characterise this affection." But fungi have been also found in lepra, psoriasis, eczema, etc., and these are not looked upon as parasitic, simply upon the ground that fungi have been observed in them. It must be shown that the parasite in molluscum is not an accidental phenomenon by clinical and experimental evidence, and as yet this has not been done; and an *à priori* argument of much moment, is the fact that parasites are not wont to produce sebaceous disease, nay, sebaceous matter is by no means congenial to their growth.

15, Old Cavendish Street, W.
April 1864.

T. RICHARDS, 37, GREAT QUEEN STREET.

From the writer

REMARKS

ON A PROPOSED SYSTEM OF

SEA TRANSPORT FOR TROOPS

EMPLOYED IN INDIA AND CHINA.

BY

CHARLES ALEXANDER GORDON, M. D., C. B.,

DEPUTY INSPECTOR GENERAL OF HOSPITALS, ARMY MEDICAL DEPARTMENT.

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1864.

* China fro

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REMARKS

ON A PROPOSED SYSTEM OF

SEA TRANSPORT FOR TROOPS

EMPLOYED IN INDIA AND CHINA.

In 1860, I wrote as follows in regard to the subject of Transport of sick soldiers from China.*

"Not only is it desirable that soldiers when prostrated by severe sickness in the more unhealthy parts of China should know that Government has provided for them the means of being quickly removed to a more genial climate, but it is sometimes a matter of life and death to the unhappy subject of climatorial disease whether he have the prospect of being within a few days removed from the place in which he languishes with the delightful feeling of home before him, or whether he must lie and suffer for weeks or months, until sufficient numbers of his comrades fall into a state similar to his own, and it becomes a matter of necessity to engage transports for the removal from the station of these wrecks of their former selves."

"Our French allies are said to have in operation during the present expedition (to China 1860) a regular system of transport to Suez by which the sick of their army and navy can be readily sent thither" and so on to their native country.

"We might I think adopt an arrangement similar to this, and considering the large armies we must always maintain in both India and China, but especially the former, it is I think absolutely essential that some better means be devised for disposing of Invalids from these, than the system at present in use affords."

* China from a Medical Point of View: Churchill, London. Page 35 et seq.

I then went on to point out that a fleet of transports should be employed for the purposes of China and India, and that to render the proposed plan as complete in its operation as possible, certain places should be selected as marine sanitaria, whence Invalids should be selected at regular and short intervals and removed to England. The subject seems to me one of such evident necessity, that this must be my excuse for bringing it forward in this form. It is however of vast importance and I propose to consider it in the following bearings, viz. :—

a. The objections urged against the present system of removing Invalids from China and India, the latter more especially.

b. The insufficiency of Hill sanitaria for the purpose they are intended to serve.

c. The necessity, therefore, for other means to be provided.

d. Special advantages for the purpose of a marine sanitarium for them possessed by certain islands of the Japan group.

e. The arguments in favor of a system of Admiralty transports, manned by naval officers and crews.

f. A sketch of how I consider the system ought to be established.

Various descriptions of vessels are employed from time to time in the conveyance of troops by sea. Thus there are 1st Men-of-War Transports, that is, ships officered and "found" in every way by the Admiralty; specially fitted up for the conveyance of troops but ready at any time to receive guns and ammunition, and thus speedily become fitted for fighting purposes. Of this class are the Himalaya, Vulcan, Urgent, &c.

2nd. Ships hired at so much per month per ton, liable to be sent wherever required. These are fitted up and provisioned by the Admiralty. A Naval agent is on board to see that no unnecessary delay takes place in the passage from place to place. The master and crew however are paid by the vessels. Of this class were the "Barretto Junior," the "Princess Royal" et cetera. During the late expedition to China many vessels were hired under these terms; they being regularly numbered upon the bows and quarter for the sake of more ready reference.

3rd. Ships the property of private owners on board of which passages are engaged for so many officers, men, women and children at so much per head for conveyance from any one to any other port, fittings of all kinds, provisions and water being found by the owners, bedding and medical attendance by the state.

The latter class of ships are almost the only ones engaged in the conveyance of troops between England and India. So very imperfectly, however, do they fulfil all the purposes of transports, that I am induced to enter somewhat into detail in regard to them, with the view of pointing out not only their obvious objections, but the means by which these might most easily and effectually be remedied.

The experience of the past few years at Calcutta has been more than sufficient to show these objections; and I have authority for referring to the Office of the Quarter Master General to prove how distinctly these disadvantages have, from time to time, not only been acknowledged, but brought to the notice of superior authority.

With exception of ships belonging to a few first class firms, the vessels that as a rule are "tendered" for conveyance of Troops, and more especially of Invalids, are by reason of their construction ill-adapted for the purpose.

The best ships sail comparatively early in the cold season, so that the inferior description have to be employed after the heat of the season has begun, and therefore at a time when in reality the necessity is greatest for fine airy vessels, on account of the high temperature in the Bay of Bengal, and necessarily tedious passage at that period of the season from the Sandheads to the Equator.

Under the present system, the military authorities are forced to trust to the contingency of a ship being offered for the conveyance of Troops. This again depends upon considerations connected with the private interest of the Owners; thus no dependence can be placed upon the regularity or precision with which troops can be embarked. In the case of Invalids this becomes a matter of very great inconvenience, not only to themselves individually, but in the mass; for, under existing circumstances, the arrivals from the provinces are, during the cold season, more numerous than the departures.

Under this system, the debris, as it were, produced among the troops by the previous hot and rainy seasons, is only during one particular period withdrawn. Means are not at present available for the removal from this country, during the most trying period of the year, of men whose health has suffered to such a degree that speedy recovery might naturally be expected, and their after efficiency ensured by such removal, but who by continued exposure to the influences under which their health began to give way, either succumb, or are permanently ruined in health and rendered unfit to provide for themselves.

As bearing upon this point I would observe that the improved means of transport furnished by Railways in India, and the fact that they are being rapidly extended throughout the country, completely alter the former state of affairs here, in which sick or weakly men could not be brought to ports of embarkation except during one particular period of the year; already, a considerable change has taken place in this respect, and there is every prospect that, within two years from the present time, there will be ample means, with some little arrangement, to have them conveyed from distant Stations with but little more discomfort than they would be exposed to, were they travelling by Railway in England. The propriety therefore, of having means at hand whereby to remove from endemic influences, men whose cases indicate reasonable prospect of recovery by such a measure, must surely be obvious.

It does not appear to me, after considerable experience in the matter, that, under the present system of engaging ships for troops, actual responsibility rests with any one person employed in this transaction. I am aware that, theoretically, responsibility is attached to them, but in practice it does not appear evident how it could be really brought home to them.

And not only can there be no individual responsibility, but under the present system different "departments" may actually be engaged in fitting up for different purposes particular portions of the same ship, no one "department" being, so far as I can learn, even nominally responsible for the whole.

An example in point lately occurred in the case of the "Hougomont" of which one portion was fitted up for convicts; a second for troops; and a third for lunatics of both sexes; these different classes requiring particular kinds of fittings, and separate scales of rations.

The great inconvenience arising from such an arrangement as this must be obvious; it would as a matter of course cease on a regular transport service being established, but I beg to submit that it admits of easy remedy even before so great a change as I suggest shall have been effected. Thus it seems to me that all persons belonging to the Army, whether they are effective soldiers proceeding to England in course of ordinary relief, or whether as invalids, time expired men, lunatics or convicts, ought to be provided for entirely, as they are elsewhere than in India, by the Military departments, all classes of civilians being in like manner provided for by Civil departments, it being understood that these two sets of departments shall not have an interest at the same time in any one ship.

I consider that the present system of provisioning freight ships conveying troops from Calcutta is open to many objections: that although there exists at this port a commissariat yard, it is only on occasions of British troops proceeding on short voyages, and chiefly within the Indian dominions, that they are provisioned from it. In the instance of troops in health, or as invalids proceeding to England, this is done by contract between the Agents of the ship and a trading firm. So great is the competition here, and so general does it seem to be that the lowest offer made is accepted, that one of two serious evils is the direct result; it becomes absolutely necessary that the supplying firm, under the circumstances mentioned, in order that they may make a certain profit from the transaction, endeavour either to place on board provisions of inferior quality, or short weight if good.

All articles of provisions placed on board ships for the use of troops are carefully examined by the regular Transport Committee, and those that are bad, or of inferior quality, rejected. This is well, but only to a certain extent. The committee cannot be responsible for the weight of different articles placed on board, neither does it follow that provisions "passed" in this way, if afterwards found to be of inferior quality from deterioration or other cause, should be issued to the troops when at sea; on the contrary, a Regimental or Detachment committee may be convened under such circumstances, and it has the very proper power to condemn and order the destruction of whatever articles may, during the voyage, be found unfit for issue to the troops.

As is the case in all committees, so here, there is no individual responsibility, nor can there in fact be any, whatever may in name be said to exist. These Committees consist at different times of different members, and it may even, and does sometimes happen that the officers composing them have had no special training for the duty.

Thus therefore it appears obvious that, as at present constituted, Committees held upon stores for the use of troops during sea voyages are only useful in a very partial degree, and that the entire system of provisioning Ships demands that a radical change be effected in it. Hence my suggestion that a victualling yard under officers of that department sent out in the first instance from the Admiralty establishments of the same kind in the United Kingdom should form part of the transport establishment at this port; the prospect of promotion being among them, as with others, dependent upon the efficiency with which their duties should be performed ; under such a system there would be no necessity for committees.

Under present arrangements, the commissariat department, although it does not as a general rule supply provisions to troops proceeding on long voyages, yet provides the various articles required under the name of medical comforts. In this respect, however, the steps necessary to be taken seem to me to be needlessly complicated. For instance, when British soldiers whether effective or invalid embark, the requisitions, or, as they are in local phraseology called, the " indents," are not prepared by the Principal Medical Officer of the service to which the men belong, but by the Deputy Inspector General of Hospitals of the local service. In accordance with the orders of the Army, and the Hospital regulations, the former functionary reports upon the sufficiency or otherwise of these, and thus is under the necessity of revising and generally of making additions to the original list ; hence it follows that to prepare these requisitions by any other than the authority who is directly responsible for them is unnecessary, and being so, is obstructive to the public service.

Under the system I advocate there would be nothing of this. The Department shipping these comforts would be held directly responsible for their quantity and quality. As matters now stand the only advantage of the inspection committee is that it removes from the Commissariat the responsibility which, for the interests of the service, ought to attach to it, and this, as already shown, without being itself more than nominally responsible. Medicines are also provided by the Medical Authorities of the local service according to a scale drawn up by themselves. The Principal Medical Officer of the British Service upon the spot is responsible that these are good and sufficient. Thus therefore, all that routine, in which he is not personally concerned, seems unnecessary.

Under present arrangements, a complication in the routine of embarking troops is unavoidable. Not only have the military returns connected therewith to be prepared upon " Forms" required by the Horse Guards and War Office ; but in addition to these, a second series of " Returns" have to be prepared for the Indian authorities upon " Forms" which are used in no other portion of Her Majesty's dominions, and are, I take leave to observe, in every way less convenient than those in general use throughout the British Service. Granted that this is a minor disadvantage, yet it is one, and like all regulations of a purely

local nature, operates inconveniently against the interests of the service at large.

Another objection against the present system of embarking troops is one which cannot be considered solely with reference to this proceeding, as it bears in no slight degree upon administration in barracks as well as in the field. I allude to that by which in India each man is provided with a set of bedding which becomes his own property ; the state of repair and cleanliness in which it is thereafter maintained depending altogether upon the habits of individual soldiers. To each man embarking, a blanket is supplied at the time his hammock is " served out" to him ; but forming a part of the ordinary baggage which the soldiers take on board is the bundle of bedding just mentioned. It may have been in use during several months, and in that time become saturated with secretions from his person to such an extent as to be absolutely offensive, and so render it impossible to maintain in this respect that degree of cleanliness which on board ship is essential to health and comfort.

I am aware that in order to effect a change in this part of the system it would be necessary to change also that according to which troops in this country are provided with bedding. I submit, however, that advantage to the public service would arise from the introduction of even this extensive change, and the substitution for it of the imperial system. Personal cleanliness would at all events be maintained under the latter.

I beg the fact may be borne in mind, that in my endeavour to point out what I deem to be objectionable in the system of sea transport of troops as it refers to Calcutta, and indeed to all other ports in India, my desire is not that in its place another system should be introduced having also a merely local application, although differing in some details from the present. I trust I may, as I proceed, make it clear that my great aim is to advocate a system which, while it would meet the requirements of India, and be necessarily in a great measure occupied with these, would also include in its operation certain others of our eastern possessions ; as well as to show that the system at present in use, and the regulations under which it is conducted, do not meet the requirements of the state to an extent at all approaching what would accrue from that which I desire to see substituted.

It is, I think, essential, while considering this matter, to recollect that India although of vast importance and extent is yet but one of the foreign possessions of Great Britain, and I believe the period has now arrived when the interests of this country are to be considered not as they concern it alone, but as they bear upon those of the Empire at large. I deem it right to make these statements in order that the views I entertain upon this question may be the more clearly understood.

With regard to the advantages likely to attend the transport of sick and weakly men by the Overland route, and the class of cases most likely to benefit thereby, I take leave to observe that the first of these points has a more extensive bearing than may probably at first sight appear.

I believe I may assert as a fact that during severe illness the desire to return speedily to one's native country becomes most powerful and indeed frequently overwhelming; that the prospect of having this strong desire realised exerts a powerful influence upon the patient to resist the disease under which he labors, and that its withdrawal produces a moral and physical depression under which many a person succumbs.

This is not writing for mere effect. It is simply asserting a fact well known in the experience of all Medical Officers who have served much abroad. I have myself had many opportunities of witnessing and deploring its existence in China, and it was this circumstance which led me strongly to advocate a regular system of transport from that country, so that our soldiers might know and feel they had the prospect of getting away by a stated opportunity, provided only they were able to bear up till then against their illness. What happens in this respect upon a comparatively small scale in China does so in India upon one much larger, and I assert that in the latter country many lives would be saved, and much permanent disability prevented, were means provided at stated periods throughout the year of rapidly removing to England such soldiers as in the opinion of the Medical Officers required the change.

As connected with this part of the subject now being considered, I would observe that the plan at present followed in India of sending sick and weakly men to Hill sanitaria, although so far as it goes most excellent, and productive of much benefit to a large number of our troops, is nevertheless so only in a comparative sense. By timely removal to the Hills for a season it is unquestionably true that many a man who would to a certainty succumb if left in the plains, not only has his life prolonged, but recovers more or less completely his original standard of health. So far however as observations have yet gone, the permanency of the recovery which under such circumstances takes place is not such as in many instances was anticipated; on the contrary, it is found that Officers as well as

soldiers, whose health had been seriously impaired prior to their being sent there, or have labored under organic disease to any considerable extent, are liable to renewed attacks of their original illness on their return to the heat of the plains, while a large proportion of both these classes have ultimately to be sent to England that their recovery may be completed, thus showing that the time lost to the service during their residence in the hills has been of little ultimate benefit either to it or to themselves.

I will illustrate this by the statistics of one year, namely 1861, taking it merely because the requisite information is, at the time of writing these remarks, nearer at hand than those of others. The rates per 1000 Invalids arrived at the following places that died, or were invalided to England, were :—

	Died	Sent to England.
At Darjeeling	50·63	139·24
Nynee Tal	21·73	118·47
Landour	147·05	147 05
Kussowlie	35·14	55·83
Murree	29·26	229·26

Nor is it only that recovery is not as a rule obtained even in curable cases by removal of the person to a Hill sanitarium. There are not a few instances in which disease is actually contracted there in addition to that on account of which the person had been sent, and he returns to the plains actually in a worse condition than he was in when he first proceeded to the "Sanitarium."

With this knowledge, several Medical Officers, myself among the number, have in official reports advocated a system whereby these sanitaria should be made available, not so much for the cure of disease as for its prevention: that not only should those be sent there who have already been broken down by disease, the result of endemic influences or of long residence in India, but also those who during the early part of their residence in this country show signs of failing health, even before actual disease has set in. Recruits also whose constitutions may be by nature delicate, or themselves physically weak, might by residence during a couple of years in the comparatively temperate climate of these Stations, become strong and efficient soldiers, instead of as is now the case falling early victims to disease, or becoming permanently injured in health.

So well known is the effect of a residence at a Hill sanitarium in preserving the health, that not a few Officers of influence, taking into consideration the high rate of sickness, invaliding and mortality among the troops in the plains, and bearing in mind the rapidly increasing facilities for concentration when necessary, now afforded by Railways and Tramways, have considered how far it might be practicable with due regard to the Military requirements of this country to have along the mountain spurs, and at convenient distances from the plains, a line of stations for British troops, where during the hot season the men would enjoy a climate somewhat approaching their own natural one; and where they would, with unimpaired health, be at all times ready to be transported by cross lines of rail toward any district in which their services might suddenly become necessary—the important posts in the plains being, as a matter of course, garrisoned sufficiently strongly to meet any sudden emergency.

We have seen, by what has already been adduced here, that as regards men already in the position of Invalids, Hill sanitaria are only of use in a comparative sense; that is as compared to a continued residence in the plains. I assert however that the comparison does not hold good when looked at with reference to a return to England, and for the following reason. Absolute removal from the endemic influences under which the climatorial disease arose is not only necessary for recovery, but the removal ought to be sufficiently long in duration to enable the system of the person once more to regain its normal condition. These ends can only be attained by proceeding beyond sea and residing for some considerable time continuously in a congenial climate, that is, one totally different from that under which health had given way.

I would here mention, in illustration of what has now been stated, that the rate of sickness and mortality among executive medical officers in India has always been notoriously higher than among Battalion officers. Some years ago an explanation was sought for this circumstance, and the one assigned was this: these officers are permitted on returning to England on sick leave to remain so short a time there that their health, impaired by service in India or the tropics has not sufficiently recovered to withstand the influences under which they are too soon thrown by being again ordered either to their original station or one not less trying. Now, be it observed, the facts here named have a significant bearing upon the matter more immediately in hand; they illustrate, although in a negative degree, the greater efficiency secured by ready removal from and residence out of an Indian climate, of a person suffering from disease caused by causes endemic in that country.

I now approach the consideration of the relative advantages of a voyage viâ the Cape of Good Hope, and Overland. Undoubtedly the effects upon an Invalid of a sea voyage are often strikingly beneficial, and not a few persons, who to all appearance are in a hopeless state of illness when put on board sailing ships at Calcutta and other Indian ports, land in England at the end of a four months' voyage so strong and robust as to have few traces, if any, of their previous desperate condition.

I am not aware however that any authority has ever attributed this beneficial change to the fact *per se* of residence in a crowded ship; on the contrary, it is rather to the combined effects of removal from endemic influences, to the advantage of uncontaminated air such as they for the most part breathe at sea, to the more congenial temperature they enjoy on the voyage round the Cape, and to the regularity of life which has to be observed by them, that the good effects upon Invalids are generally attributed.

As however in the instance of Hill sanitaria, so it is in reference to the long sea voyage. Although beneficial as compared to continued residence in the plains of India, the comparison ceases to hold good when taken with reference to speedy return to England, and, in the case of soldiers, the advantages they then have as regards climate, Hospital accommodation, and food.

That this is indeed generally acknowledged is daily illustrated in the case of Officers. Those whose means are sufficiently ample and have the option of proceeding homewards by either route almost invariably prefer that viâ Egypt, being fully aware that whatever be the restorative effects upon health of a sea voyage, they are of a degree inferior to those obtainable by speedy return to the United Kingdom.

With the exception of the subjects of a small number of diseases, we now know that it matters little at what period of the year Invalids and weakly men arrive in England from tropical countries; indeed since the more general employment by passengers of the overland route, it has become apparent that in many instances the winter cold of England instead of being pernicious has exercised a good effect, and so also as regards troops arriving from abroad in course of ordinary relief.

The exceptional cases are those of Chest affections, certain forms of Rheumatism, and secondary Syphilis. Men affected with either of these unquestionably suffer if they arrive in England during the colder portion of the year; the fact must be borne in mind however that, as regards men suffering from either of these diseases few, if any, ever again become efficient soldiers, and hence one of the principal arguments in favor of the Overland route cannot be applied to them.

There are some other classes of persons for whom the route viâ the Cape is undoubtedly better adapted than any other, namely Military convicts and lunatics. A certain number of time expired men would from time to time be required as guards and attendants upon these; but as we shall presently see, were the system I propose in full operation, very few occasions would arise in which these classes could not be accommodated in the class of ships, the employment of which I desire to see introduced.

I am aware that many officers of great experience consider that good merchant vessels, properly fitted and supplied by the Departments concerned, form the best possible mode of conveyance as regards comfort, expense, or the necessary expedition in transit. Each of these points must now be separately considered.

As regards the comfort of men and Officers, whether in health or as Invalids on board first class passenger ships, I to a certain extent and willingly bear testimony. That as a rule the men have excellent food on board these vessels I readily admit, but I do not perceive why they should have better food than they have on board regular man-of-war Transports. There is however one point in reference to this part of the general subject to which a paragraph may be devoted.

The dietary on board ships taken up by the Indian Government is at present more liberal than that adopted either in Naval transports or on board vessels hired for the conveyance of troops to our colonies. In some respects also the scale upon which Medical comforts are allowed is more liberal than in either of the two latter instances. What is good however in the Indian system ought no doubt to be retained, and therefore I consider no change ought to be made in either of these respects: nay more, their extension throughout the service generally would conduce much to the comfort and well-being not only of soldiers but also of their wives and children. There however seems to me no good reason why, were these scales authorised, troops should not have the advantage of them as much on board one class of ships as on board another.

The accommodation on board of hired ships is as a rule tolerably good, but for the requirements of sick men it is, I hold, much inferior to what exists on board regular Transports, while the numerous appliances and arrangements connected with a sick bay or hospital are, as compared to the latter description of

vessels, altogether wanting; nor can the owners under present regulations be forced to provide them, even were it practicable to do so, which it is not.

Officers are no doubt extremely comfortable, especially when there are agreeable passengers on board; nor is it by any means rare to hear regrets expressed on board at the voyage having come to an end. I would submit however that some of the circumstances that give rise to this great comfort are not always conducive to the maintenance of strict Military discipline, and are of a nature seldom if ever met with on board ships of war whether fitted up as transports or not.

As regards the comparative expense of transport of troops by passenger ships and by a line of vessels such as I advocate, a number of points must be taken into consideration in discussing the question, which may possibly not at first sight present themselves, and are of a nature not to be capable of being represented by mere arithmetical figures.

It is not denied that troops are brought out from England and sent home from India under the present system at a rate which in itself cannot be called otherwise than moderate. We have already seen however that the competition which now exists in this respect among agents and contractors is one cause of evils in that system; and we must bear the fact in mind that not only have the interests of the public service to wait the convenience of shipowners and their brokers, but the contracts cannot be at all times conveniently entered into: neither must we forget that on each occasion where troops have to be conveyed in either direction, the same steps have to be repeated in providing transport for them and the same expense again and again incurred; and this without making any permanent increase to the means at the disposal of the state for removing troops.

It is self-evident that the expenses of whatever fittings are necessary in order to adapt a vessel for conveying troops are fully taken into consideration by the shipowner or agent at the time of entering into the agreement, and that the amount per head which he charges must include all expenses incurred on their account. It is equally obvious that fittings and arrangements which are sufficient for one voyage would be so for several, and that therefore to fit up a ship as a regular troop ship in a manner sufficient to last during several years, would cost comparatively little more than the amount already expended upon arrangements which are not intended to last more than a very few months. Here then, when we consider the large number of ships engaged every year even for the ordinary purposes of transport, is a drain upon the finances of the state which, although very difficult to represent by figures, forms nevertheless an item of very material consequence. In times of war, or under other circumstances which render the movement by sea of large bodies of troops necessary, this becomes still more apparent and inconvenient.

It would be superfluous to state the fact were it not necessary in order to illustrate my views, that as with ships so with officers and men engaged in the transport of troops under the present system, Government has no interest beyond their mere temporary engagement: during the brief period however they are so employed, Government, which pays a certain amount towards the wear and tear of the vessel, is also made to contribute a certain proportion towards the wages of her officers and crew.

While this is taking place, a number of vessels built at great cost lie as useless hulks in our Naval ports at home; Naval officers, especially of the junior grades, are left unemployed, drawing from the State a stipend which however inadequate towards their own becoming support is nevertheless a great drain upon the public, for which the recipients have not the opportunity granted them to yield an equivalent in duty performed: and as regards sailors, I argue that were the numbers now employed in ships conveying troops similarly occupied on board man of war transports, the discipline they would there undergo and the general training, would admirably fit them to take their place on board fighting ships whenever the necessity should arise.

Many of the Naval ships alluded to as now lying unemployed on home stations are no doubt unfit for their original purpose since the late revolution effected in Gunnery. This however is only in so far as the requirements of the western hemisphere are concerned; eastward of the Cape they are, and for many years, will probably continue, sufficient for any purpose they are likely to be called upon to fulfil.

Under the present system, troops are sent from England to India so as to arrive there during the few months over which the cold season extends: and up to a certain time several circumstances combine to render this necessary, the principal being the defective means of conveyance inland to the different military stations. This objection however, as we have seen, now no longer exists to the extent it did, and before long will have altogether ceased.

In like manner, soldiers whether in health or as invalids are usually embarked for England during the same period of the

year, and hence arises a result to which I solicit some attention. Men who during the early period of the year fall ill, as already stated, have to undergo the risks and dangers of the hot and rainy season, but there is another respect in which not only the interest of the individual soldier but those of the mass suffer in consequence of weakly men not being quickly removed, and replaced by those who are efficient. It is this.

Each regiment has to perform a certain amount of work and hence a certain amount of wear and tear to undergo. By so much therefore as the number of men over whom this duty is distributed becomes diminished, so much greater does the wear and tear become upon the smaller number who have to perform it; not only do they continue as before subject to the ordinary causes of disease by which their comrades had become prostrated, but are exposed in addition to the additional physical depression caused by the increase of duty thrown upon them.

With regard to the question of length of time spent by troops at sea under the present system, and that which I advocate, a few words seem to me to be all that is necessary. As at present performed, the voyage to England from Calcutta takes up on an average one hundred days. I elsewhere show the numbers of men who may be expected yearly to have to perform this voyage; and I show how desirable it is that the places of men who become unfit for duty should be taken by men in health. If therefore we bear in mind the fact that the voyage Overland to or from England could be readily effected in thirty-five or forty days, the great advantage of this route as a saving of time must be at once apparent.

There is however another consideration of great importance in its bearing upon effective soldiers: the longer the time a man is without performing his ordinary drills and duties, the more does he forget them, and the greater difficulty does he experience in regaining what he has lost: it follows therefore that a body of troops landing from a voyage of thirty or forty days must be in an actually better state of effectiveness than they would be after a voyage of a hundred days and upwards.

The conveyance of warlike and other stores eastward of the Cape is at present effected almost solely by merchant ships hired for the purpose; these vessels are in one respect upon the footing of those employed in the conveyance of troops, namely, that their particular contract ended, Government has no further claim upon them. It is obvious to me that although, as already stated, the transport of stores would follow as a secondary consideration, yet a very great saving in money would be in this way brought about; inasmuch as Government being in that case the owners of the vessels, the profits that now go to the shipping firms would necessarily be saved to the public: stores of various kinds might also not only be brought out by the vessels conveying troops, but ships might be employed in their conveyance on occasions when they could be thus spared.

Another good result that would accrue from such a system, especially if combined with the establishment of a victualling yard as already advocated, is this. We know that at inland stations in India one great cause of difficulty of regiments against the condemnation by committees of rations of inferior quality tendered for the use of the soldiers by Commissariat contractors, is the fact that, in the event of these rations being condemned, several hours, or the greater part of a day, must elapse before such articles as may be substituted can be obtained; at other stations, so great is the dearth of vegetables, and insuperable under existing circumstances the difficulty in preserving them, that scurvy is of yearly occurrence among the troops.

Were there at these stations stores upon a sufficiently large scale, not only would the evils I allude to cease, but the troops would have the advantage of an occasional salt ration which would in itself be a great advantage to them on sanitary considerations, while the regular supply of preserved vegetables would prevent a recurrence of the disease just named.*

Were a line of transports once established not only would the amount of provisions required for troops proceeding homewards be regularly brought out by them at a far less cost than they can be under present circumstances, but a sufficient quantity would be at all times available to meet such emergencies at distant stations as I have now alluded to.

A vast proportion of the materiel contained in Arsenals in this country is conveyed from England; and it would seem that this must continue to be the case for several years, in an even greater degree than at present, in consequence of the changes now being made in the armament and equipment of troops, as well as in other warlike appliances.

There is, however, one other point to which I would allude in this place; namely the apparent anomaly presented in the pre-

* With regard to preserved vegetables, it seems strange, that no individual or company has yet undertaken to cultivate and preserve in India, a quantity sufficient for the requirements of the British forces in that country. Could not this be done?—C. A. G.

sent state of affairs; that England is under the necessity of employing private firms to convey to her richest and most important foreign possession the troops required to maintain that possessions in her grasp: this anomaly also is further shown in the fact of the forces employed there being greater than those in all her other possessions united.

A cursory glance at a map will at once serve to show how much more extensive are our possessions eastward of the Cape of Good Hope than to the westward of that promontory; nor is it probable, except under a temporary emergency that the points at which troops will have to be maintained on the European side are likely to become more numerous than they are at present; we may reasonably believe however that on the Asiatic side, and especially in the far east, they are likely to undergo a considerable increase.

To the westward the necessity is fully acknowledged of having a fleet of organised transports of the Royal Navy for the purpose of moving troops, maintaining the arsenals in an effective state and keeping up the supplies of provisions for the land and sea forces by whom these possessions are preserved. That this system of transport is inadequate to perform all the services required of it must be allowed; it is not however to this point that I now solicit attention, but to the fact of regular Naval ships being employed as Transports at the very places where ordinary hired vessels could be obtained far more readily and at a cheaper rate than they can be at more distant places.

Nor is the employment of Naval transports confined to the possessions westward of the Cape; vessels of this description are sent to the Cape itself, to China, and to Australia, thus shewing their acknowledged-adaptation for distant service, as well as that within a more limited sphere.

Until very recently, systems and usages adopted throughout other portions of Her Majesty's dominions did not find a place in India. The circumstances under which this state of matters was permitted to exist are now altogether changed. The country itself is no longer an isolated possession but an integral part of the British Empire, and therefore the time seems to have arrived for extending to it the advantages of the general system of administration as regards the matters now being considered which are adopted throughout all other portions of the empire.

In connection with the system of transports now being advocated I consider that India, China, and the Straits Settlements ought in this respect to be brought under one management. The Mauritius is from its geographical position so isolated that it ought more appropriately to be looked upon as being within the Cape sphere; Australia again is so completely out of the line I now propose, and the journey from there homeward by overland route possesses so few advantages as regards time over the passage, viâ the Cape of Good Hope, or round Cape Horn, that I think it ought also to be excluded.

As having a close bearing upon the matter immediately in hand, I beg to remark that for our troops employed in that part of Asia eastward of India there is at present no place in the nature of a sanitarium; Singapore has, it is true, been recommended for this purpose, and extensive barracks for a British regiment have been erected there but the idea has not been further carried out, and it does not seem, from the high temperature, and other circumstances incidental to the island that it would be well adapted for the purpose. Penang is no doubt in some respects better suited than Singapore for a sanitarium, by reason of the great height of its peak, but both these islands are inconveniently situated as regards China, and it does not appear that they could be made available with any great advantage for India.

The various requirements as regards climate, and position as they bear upon the necessities of Invalids, whether Naval or Military, along the coast of China are possessed by Nagasaki, which it is almost needless to observe is the seaport town of Kiu Siu, the most southern of the Japan group of islands. The advantages of that place as a sanitarium are fully described by various writers who have visited it including its moderate climate, the excellence of its water, the beauty of its scenery, and abundance of provisions with the single exception of mutton, nor must it be forgotten that it possesses the great advantage of being easily reached in a period of four to eight days from any of our stations along the coast of China.

Little more than years ago it was seen on the spot itself that building materials both stone and wood were abundant and workmen could be easily hired; in so far too as the inhabitants were concerned there was every readiness to permit our Government to rent a site for such a purpose.

While I am writing, political affairs may have altered this considerably; but if they have, it is to be remarked that these very affairs may render available for a similar purpose one or other of the islands in the straits of the Corea; any of which so far as can be ascertained is especially well adapted as a sanitarium.

As already observed, I do not consider that in the case of a person whose health has become actually broken by the effects of a foreign climate, any thing short of a change to his own native country will renovate the damage done; yet as also observed, removal from endemic influences in the early stage of an illness checks the further progress of the malady, and at a later stage saves a life which would be sacrificed by further residence in the locality. In these respects Hill sanitaria in India effect a great deal of good; and so would a removal to one or other of the islands now named benefit to an even greater extent our soldiers employed in China.

I consider I am justified in saying to a greater extent, for the reasons that the belt of sea which separates Japan and Loo Choo islands from the mainland of China is sufficient to place the two former under totally different circumstances as regards climate and endemic influences from the latter, while in India, the mere elevation of Hill sanitaria is not of itself sufficient to create so complete a change in circumstances.

In further urging this portion of my subject, I would observe that in so far as an opinion may be formed from the progress of events in the far East, the necessity for the employment of troops and sailors there will to a certainty increase during the next few years. However capable the native Indian sepoy now employed in China, may be to cope with the troops of that country in the present imperfectly disciplined state of the latter, and however desirable it may be that Indians who withstand the climate of that country so much better than British soldiers, should as long as possible be permitted to take the brunt of work to be done,—it is clear that ere long the circumstances of the Chinese, whether as Rebels, or Imperialists will have so completely altered, that a great increase to the British Forces there must become necessary. Hence one cogent reason that arrangements such as I propose should be made with the view to preserving as far as practicable the efficiency of these men.

There are also strategic considerations bearing upon this part of my subject to which I will but very briefly allude: they perhaps do not strictly come within the sphere of a medical officer, yet appear to me sufficiently important to be here alluded to.

As is well known, the extension of Russian territory to the mouth of the Amoor has given to that power the advantage of free egress at certain seasons of the year: as with her ports on the north Atlantic however, so here, in the north Pacific, egress is during several months annually prevented by ice.

It is openly asserted by persons capable of forming an opinion upon the matter that an object of great interest on the part of the Czar is to obtain a footing in the Corea: did he possess a dock yard and arsenal there, the sea would be as open to his ships from the east, as it is for those of Britain in the west. Hence it is evident that to possess a settlement upon the islands in the near neighbourhood is desirable upon other grounds than those of a purely sanitary nature.

How the direct bearing of these remarks upon the subject of transports is to be established will I trust become sufficiently apparent as I proceed.

It will be well however, if in this place I consider briefly the nature and extent of the services which a fleet such as I propose would be called upon to perform.

Under ordinary circumstances, five Regiments will yearly be removed from India and replaced by an equal number from home. If we consider officers, women, and children we shall find that 1000 persons is an under estimate: 1100 would be nearer the actual number, but let us for the sake of convenience say 1000. This would in round numbers give 5000 persons to be conveyed annually from England to India in the course of ordinary relief.

The five regiments going home, what between decrease from disease and volunteering may be taken at a strength of 600 each: that is for the year 3000 to be conveyed to England.

The number of men who return annually to England as invalids may be stated at 2000, or with their families 2200, and those who take their discharge may be put down at 800. I fear also the annual loss by death must be put down at 2000. To replace all these, an equal number of recruits must be sent out from England.

At the present time we may consider the Military Force in China, to consist of three British Regiments, two Batteries of Artillery, one Company of Royal Engineers, and in addition three Native Indian Regiments.

The British, with the exception of the Engineers are sent periodically from India, and both white and black troops are relieved every three years; the former being sent out from and brought back direct to the United Kingdom.

The casualties from sickness among our troops there, may, if we judge from what took place during the late expedition, be taken at 5 per cent. by death, and four per cent. by Invaliding. This is irrespective of the ordinary contingencies of battle, and these must necessarily depend upon particular service which the

troops may from time to time be called upon to perform. Let us for the sake of using round numbers say the whole casualties in China amount to 10 per cent. on our strength there. This would give us yearly about 175 deaths and 120 to 150 Invalids; the latter class requiring conveyance to England, and both classes having to be replaced by fresh troops brought out.

The small Indian force by which the settlements in the straits of Malacca and the neighbourhood are held need scarcely be taken into account in the present question; all requirements as regards them could be readily fulfilled by vessels in transit between India and China.

So also with Burmah; troops are sent thither from and brought back to Madras as occasion requires, and all their necessities could be met by such a system as I propose without its more important operations being scarcely affected.

Among the benefits to the public service that would indirectly arise from this system of transport one seems to me to deserve especial consideration. It is this. As matters at present stand, soldiers embarking for India with their regiments feel that they can only hope to return to their native country under one or other of the following circumstances; either when the regiment having completed its tour of foreign service is once more ordered home: when having completed the first period of their enlistment they take their discharge and thereby as a rule sacrifice ten working years of their life: or having completed the second period, they return for the purpose of being discharged with whatever pension they may be deemed entitled to,—or else, and this happens by far the most frequently, their health having broken down, they are sent home as invalids. Now, I believe that had we a regular organised line of transports in which the passage of a few men would not be of material consequence in a pecuniary point of view, as it is and must always be in freight ships, a certain proportion of non-commissioned officers and well behaved soldiers could readily be sent home from time to time for temporary duty with their depôts, whence as a matter of course they would in rotation obtain furlough to visit their homes, thus they would in due time not only return to their regiments with confirmed good health, but the training they themselves had undergone in Britain and the renewed energy imbibed, would enable them to pass on to the regiment generally several of the advantages which they themselves had derived: thus I believe, increased efficiency of the mass would be insured while individuals would be benefited to an incalculable extent.

I now come to state as briefly as possible the plan according to which I conceive such a system of transport as I propose could be conducted, dealing however with generalities, and leaving details to be considered hereafter, in the event of my views being entertained, by the authorities.

In addition to the naval transport already available on the coast of China, and which indeed would have to be considerably increased, it would be necessary that a certain number of ships of this description should be placed upon the Indian side, one division of these being for the requirements of the Bombay Presidency, having their Head Quarters there, and another for Madras, including Burmah, and Calcutta, having their Head Quarters and all necessary establishments at the latter place.

At each of these principal stations it would be necessary to have a naval officer as agent for transports; a victualling yard would also be indispensable: the command of the whole would be vested in the senior naval officer on the spot, who would on the one hand act in concert with the Commander-in-Chief in India, and on the other be amenable to the Admiral commanding the India and China naval station.

The ships themselves, like all others of the Royal Navy would be in commission for the ordinary period of three to five years, thus it may be calculated two at least would return yearly to England in course of relief; two others from home coming out to supply their place. Supposing then that during three months of the year, the intense heat of the passage up the Red Sea be held, as it no doubt is, an objection against troops proceeding by that route, the ships going home as just stated might profitably be employed in conveying viâ the Cape such classes of men as we have seen might still continue to be sent in this way, while the vessels coming out would doubtless bring their quota of drafts, as well as a large amount of stores of various kinds.

We have ample reason to believe that no difficulty would be experienced in so far as permission to make use of the means of transit through Egypt is concerned; matters in this respect are already upon a much better footing than they were when my first remarks on this subject were written. In fact the plan of sending the season's drafts by this route is contemplated now in England: I consider therefore, I am justified in believing that no political considerations are under existing circumstances likely to militate against sending soldiers whether in health or as Invalids by the overland route; and all other circumstances aside, when we bear in mind the signal results which in 1857

followed the transport of troops from England to India by this route, it would seem that this consideration alone, even if not attended by the other advantages already enumerated would of itself be sufficient reason why it should be adopted.

Nor must we forget that a rival but at present extremely friendly power is almost monthly adding to its fleet of steam passenger ships in the eastern seas, and that on this ground alone the interests of England demand that she too should have corresponding vessels, of an equally convertible nature.

We have seen that the circumstances of the service itself would require that vessels from time to time proceed viâ the Cape; and that these would be available for certain purposes already described: in so far as these are concerned, no special arrangements would be necessary in regard to the ships beyond what are now adopted where regular transports are in use. With a view however to indicate the measures required under the circumstances proposed, I will as it were commence at our most distant stations, and thence proceed viâ Egypt homewards.

Presuming that a sanitarium such as I have already advocated were established at or near Japan, sick would be sent thither from the various ports along the coast of China, those only being directly shipped for home, whose cases from the very commencement showed that no other measure was calculated to check the progress of the disease. We have already upon the China station so many vessels belonging to the Royal Navy that communication between the various places there is sufficiently easy: with the concurrence of the admiral, men might at almost any time be removed to a sanitarium,—those who had recovered brought back to their regiments, and those who required still further change conveyed to Hong-Kong for the purpose of being there shipped for England.

Here, the necessity for steam transport was during the late expedition fully recognised; the tedious voyage of sailing ships along the straits of Malacca, the light baffling winds and high temperature in that region producing a severe degree of mortality among Invalids sent in this way, but all of which evils could either be avoided, or materially modified were the ships so employed propelled by steam.

It might be advisable, at any rate for some considerable time to come that Invalids and weakly men from regiments in British Burmah be conveyed in the first instance to Madras, but in the instance of regiments being relieved and those completing their tour of foreign service there does not appear any good reason why they should not proceed thither direct from home, and in like manner proceed direct to Britain.

The greatest and most constant drain would necessarily be to and from Bengal and Madras itself; that from Bombay, on the one side, and our eastern stations on the other producing as it were subsidiary currents, to this the main one : it would moreover, in so far as the overland route is concerned include Ceylon, but for the requirements of voyages that might still continue necessary viâ the Cape, each of these principal places might remain distinct as is the case at present, or ships to and from Madras might touch at Ceylon as occasion should require.

The requirements of Aden, might be readily supplied by the vessels employed in the service of the principal possessions : in a manner similar to what has been already indicated in regard to the other minor stations connected with India and China.

It seems almost unnecessary to mention that arrangements would be required to maintain a supply of fuel as well as other requirements for the service not only at each of the principal starting points, but at Singapore, Ceylon, Aden, and Suez.

The nature of the establishments necessary to be kept up in Egypt would be in proportion to the use made of this route for the transport of stores, as well as the number of troops in health and as Invalids who would travel by it : at Suez a building would have to be provided, capable of accommodating such men as during the voyage to that place may have become so ill as to be unfit to continue the journey: this would involve the appointment of a Medical Officer and Hospital Staff: a purveyor would be required to provide diet for the sick, make arrangements for landing and embarking the men as the case might be, arrange with the transit administration for the conveyance across the isthmus of the men, and communicate with the intermediate stations between it and Alexandria in order to have the wants of the men attended to at each of these: in addition to these duties he would perform those as regards the hospital itself that are laid down in the Regulations for his department.

It is calculated that the journey by rail from Suez to Alexandria would be performed in less than fourteen hours: indeed it ought under ordinary circumstances to be effected in eleven to twelve ; thus it does not appear that any further establishment would be required on the way than the present refreshment rooms at the stations in the desert and along the route with certain increase to the accommodation connected with these : thus, special arrangements at these would be necessary to supply troops with accommodation for ablution, and other neces-

sary purposes, keeping in mind the large numbers who would from time to time travel by particular trains.

One railway carriage would be set apart for the accommodation of Invalids affected with intestinal disorders the special arrangements required for cases of that nature being there provided. It would also be very desirable that one non-commissioned Officer and two or more men of the proposed hospital at Suez should accompany across the desert each detachment of invalids or troops in health arriving there. These men would themselves be acquainted with the nature of particular arrangements at each of the intermediate halting places, and not only in this respect but in many others would be able to give valuable assistance in adding to the comfort of the men during transit.

At Cairo the train might stop one or two hours; here coffee or tea with bread or other necessary refreshments could be provided under arrangements entered into by the purveyor; here also the men would have an opportunity of making themselves as comfortable as circumstances would permit preparatory to starting on the second portion of the journey.

It is considered that were matters arranged so that troops proceeding homewards or coming eastward were to commence their railway journey through Egypt in the evening, the whole of it from Suez to Alexandria or vice versâ could with a little management be performed without any further halt than what has just been stated, and it would be a part of the duties of the Staff employed on this service to see that this was done.

A receiving vessel at Alexandria similar to the "Princess Charlotte" or "Hercules" at Hong-Kong would be available for the reception of invalids or troops in health arriving from India, so also for troops from England pending arrangements for their transit across Egypt and embarkation at Suez. It is almost unnecessary to observe that as adjuncts to this part of the arrangements, means of communication between the ships at either side of the isthmus with the shore would be required, as well as ready conveyance for the troops and their baggage between the jetty and railway station.

To meet the requirements created by a service, such as is here advocated, a certain amount of increase would doubtless be necessary in the number of naval transports employed between the Mediterranean and England; but with our large harbour, arsenal, and victualling yard at Malta it is considered that no material alteration would be required in the ordinary arrangements of the service as there carried out.

By means of the telegraph extending from Jubal in the Red Sea, and available at almost every point onwards from there, intimation might be received at Alexandria, Malta and England in sufficient time to enable all arrangements to be completed for the reception of troops about to arrive from India; in like manner intimation could readily be conveyed to Suez in regard to those about to embark in England for any of our eastern possessions.

As already stated, details would hereafter have to be arranged, in the event of my views being considered practicable; I venture to state however that were they adopted, a complete system of transport such as I advocate ought to be in working order within two years from the present time.

C. A. GORDON.

Calcutta,
January 1864.

ON TUMOURS

IN

VOLUNTARY MUSCLES

WITH AN

ANALYSIS OF SIXTY-TWO CASES AND REMARKS ON THE TREATMENT.

BY

W. F. TEEVAN, B.A., F.R.C.S.,

SURGEON TO THE WEST LONDON HOSPITAL,
DEMONSTRATOR OF ANATOMY AT THE WESTMINSTER HOSPITAL,
AND FORMERLY DEMONSTRATOR OF ANATOMY AT
UNIVERSITY COLLEGE, &c.

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Art. V.

On Tumours in Voluntary Muscles; with an Analysis of Sixty-two Cases and Remarks on the Treatment. By W. F. Trevan, B.A., F.R.C.S,, Surgeon to the West London Hospital, Demonstrator of Anatomy at the Westminster Hospital, and formerly Demonstrator of Anatomy at University College, &c.

Tumours affecting muscles, in common with other parts, are not infrequent, but it is exceedingly rare to find them developed and isolated in the body of a muscle. For the surgeon they possess great practical interest, and, so far as I have been able to ascertain, but little mention of them is to be found in any author, no statistics have been collected regarding them, and no definite rules laid down for their treatment.

T. W. Chevalier, who obtained the Jacksonian prize essay in 1822, for his dissertation on the 'Injuries and Diseases of the Muscular System,' has made a few remarks on 'Tumours, as affecting Muscles.' "They are, for the most part, independent of the muscles, unless being confined under them they encroach and irritate and so form adhesions, or unless they may have begun in the cellular substance which partly composed those organs." Nearly all his evidence is entirely of a negative character.

According to Rokitansky,* "The muscular system is rarely the seat of morbid growths, except when it is involved in those which have originated in other tissues."

Gross† is of opinion that "Various morbid growths occur in and among the muscles."

In Holmes's 'System of Surgery,'‡ it is stated that "Tumours of different kinds are occasionally found in muscles."

J. C. Warren,§ in his well-known work, when considering "muscular tumours," states—"These are formed in the substance of the muscles. They are not very common. On external examination they are less distinctly defined than steatomatous tumours, and less moveable. When the muscles in which they are situated are perfectly relaxed they possess a considerable mobility; when they are firmly contracted the tumour is quite fixed, and these circumstances constitute their most remarkable character. The diseased part is not very easily distinguished from the healthy; so that in operation it is necessary to trench deeply into the surrounding muscle. They are more frequently accompanied with pain than cellular tumours; and more disposed to degenerate into malignant affections. Their origin is often traceable to an accidental injury, a blow, strain, or continued pressure. After removal they are apt to reappear." He also relates a few cases, the nature and origin of some of which must be considered very doubtful.

* Sydenham Society's edition, vol. iii. p. 312. † Gross's Surgery, vol. i. p. 747.
‡ Holmes's Surgery, vol. iii. p. 539. § Warren on Tumours, p. 64.

Bouisson* makes some general remarks—"Les tumeurs qui se développent dans l'épaisseur des muscles, et dont on possède une connaissance exacte, sont encore fort peu nombreuses. Le cœur est le seul organe musculaire dans lequel on ait signalé des productions morbides variées; mais ces lésions n'intéressent qu'au point de vue de l'anatomie pathologique, et souvent elles ne sont reconnues qu'au moment de l'autopsie. Quant aux muscles de la vie animale, ils ont à peine été compris dans les investigations qui pouvaient éclairer ce sujet; et si l'on excepte quelques tumeurs inflammatoires, quelques hypertrophies limitées, divers kystes contenant des liquides ou des entozoaires de différentes espèces, c'est à peine si l'on a recueilli quelques cas de tumeurs, resultant d'une lésion spéciale du tissu musculaire, et dans lesquels la symptomatologie et la thérapeutique aient été l'objet d'une attention fructueuse."

Parmentier† has made some remarks on cancerous tumours in muscles, and Demarquay‡ has written a chapter on erectile tumours in muscles. To both these authors I shall have occasion to refer.

Liston§ stated, "Structural disease of any kind in muscle is indeed but rarely encountered."

Various writers have discussed the subject of syphilitic tumours in muscles. It is not my intention to include them in the class of cases under consideration, for I think they scarcely come under my definition, and ought rather to be looked upon as inflammatory swellings or exudations. I may mention, however, that to Bouisson belongs the merit of having been the first to point out their pathology and treatment.

I have from different sources collected the records of upwards of one hundred cases of tumours in muscles, but as, in many instances, the tumour affected several contiguous muscles, it might be fairly objected, that the growth did not originate in the body of the muscle, but in the intermuscular space. I have therefore excluded all such. Although the tongue is often the seat of tumours, yet its muscles are so small that it would be exceedingly difficult to single out any one as affected in a given case. For the same reason many other muscles will also escape notice.

In selecting the extracts of cases I have endeavoured, as briefly as possible, to state only some of the more important facts, leaving the reader to refer to the authorities named for the details. In several instances the cases were wanting in particulars. The following are arranged according to the frequency of each description of growth:

1. *Medullary cancer* in the *pectoralis major* of a female, aged thirteen. The tumour, which was the size of the fist, and suppo[illegible]d to have been caused by a fall, was excised. The recurrence took place before the wound was closed, and death ensued a few months afterwards. (Compend. de Chirurgie, tome ii. p. 205.)

* Tribut à la Chirurgie, tom. i. p. 538.
† L'Union Médicale, Août 29 and 31, 1861. ‡ Ibid., Dec. 26, 1861.
§ Med. Chir. Soc. Trans., vol. for 1843, p. 127.

2. *Medullary cancer* in the *pectoral* muscle of a male. It was of large size, of eleven months' duration, supposed to have been caused by a sprain, and quickly proved fatal. (St. George's Hosp. Mus., Series 5.)

3. *Medullary cancer* in the *pectoralis major* of a man, aged thirty-four. It was as large as a melon, and of two years' duration. The tumour and entire muscle were excised, and death ensued on the twelfth day. (Ed. Med. and Surg. Journ. vol. ii. for 1861, p. 612.)

4. *Medullary cancer* in the *gluteus maximus* of a man, aged sixty-six. It was as large as a hen's egg, and of two months' duration. Excised. (L'Union Médicale, Août 29, 1861.)

5. *Medullary cancer* in *gluteus maximus* of a woman, aged fifty-five. The tumour was of the size of an adult head. It was excised together with part of the muscle. Recurrence took place in five weeks, and death followed three weeks after. (Med. Times and Gaz., vol. xxxvii. p. 655.)

6. *Medullary cancer* in the *sartorius* of a man, aged fifty-eight. The growth, which was as large as an adult head, and of two years' duration, was supposed to have been caused by laceration of the muscular fibres some years previously. Excision, followed by recurrence. (Lancet, vol i. for 1861, p. 287.)

7. *Medullary cancer* in the *sartorius* of a young man. There were several tumours of a similar nature round the hip-joint of the same side. (St. George's Hosp. Mus., Series 5.)

8. *Medullary cancer* in the *deltoïd* of a female, aged twenty-three. The growth was of small size and was excised. Fungoïd tumours were reproduced in the vicinity and attained an enormous volume. Death took place two years after the operation. (St. Thos. Hosp. Mus., No. 32.)

9. *Medullary cancer* in the *deltoïd* of a man, aged forty-two. The tumour was as large as an orange, of six months' duration, and grew in the same place as that from which a recurrent fibroïd tumour had been removed some time previously. Excised. (Lancet, vol. i. 1861, p. 315.)

10. *Medullary cancer* in the *rectus abdominis* of a female, aged fifty. There was also a cancerous tumour in the left labium. At the post-mortem all the internal organs were found quite free from malignant disease. (Dub. Hosp. Gaz., April 1, 1846, p. 254.)

11. *Medullary cancer* in the *rectus abdominis* of a female aged forty. Death took place from melanosis. (L'Union Médicale, Août 31, 1861.)

12. *Medullary cancer* in *biceps humeri* of a man, aged thirty-seven. The tumour, which was of one year's duration, was excised. Recovery. (Lancet, vol. ii. 1862, p. 700.)

13. *Medullary cancer* in short head of *biceps humeri* of a male and of two years' duration. Was excised and followed by recurrence. (St. George's Hosp. Mus.)

14. *Medullary cancer* in *soleus* of a female, aged fifty. The tumour was very large, and of two years' duration; was excised, and death

ensued from consecutive hæmorrhage. At the post-mortem, no trace of cancer could anywhere be found. (L'Union Médicale, Mars 6, 1851.)

15. *Medullary cancer* in the *rectus femoris* of a male, aged seventy. This tumour, which was of the size of the fist and of two months' duration, was supposed to have been caused by a fall. It was excised, and recurred four times. (L'Union Médicale, Août 29, 1861.)

16. *Medullary cancer* in the *biceps femoris* of a young woman. Amputation at hip-joint, followed by recovery. A previous growth had been excised. (Exhibited at Path. Soc., Jan. 6, 1863.)

17. *Medullary cancer* in the *gastrocnemius* of a male, aged eighteen. The tumour, which was of nine months' duration, was excised. It rapidly grew again, and was excised a year after the first operation. Three weeks afterwards fungoïd tumours appeared in the sore, and the leg was amputated above the knee. Death took place ten weeks from date of amputation. At the post-mortem no cancerous deposit was found in any other part of the body. (St. Thos. Hosp. Mus., No. 30.)

18. *Medullary cancer* in the *crureus*. There were two tumours, each the size of a walnut, contained in cysts. (Bull. de la Soc. Anat. de Paris, vol. for 1859, p. 10.)

19. *Scirrhus cancer* in the *brachialus anticus* of an old woman, of three years' duration and the size of an orange. The arm was amputated, and patient recovered. (Lancet, vol. i. 1860, p. 118.)

20. Several small, "oval, hard, and white" carcinomatous tumours in a *pectoral* muscle. The fasciculi were described as healthy. (Mus. R. C. S., No. 345.)

21. *Melanotic cancer* in the *rectus femoris* of a young female. The tumour was encysted, of the size of a hen's egg, and of six months' duration; was excised, and patient recovered. (J. C. Warren on Tumours, p. 65.)

22. *Fibrous* tumour in the *biceps humeri*. It was of the size of a walnut, and was taken from the body of a man, aged sixty-five, who died from chloroform when about to have the thigh amputated for a large tumour of the same nature. (Trans. Path. Soc., vol. vii. p. 340.)

23. *Fibrous* tumour in the *deltoïd*. (Lancet, vol. i. 1857, p. 186.)

24. *Fibrous* tumour in the *gastrocnemius* of a girl, aged nine. It was of ten months' duration, and the size of a walnut; was partly excised, but recurred, and leg was amputated above knee-joint. (Trans. Path. Soc., vol. vi. p. 345.)

25. *Fibrous* tumour in the *pectoralis major* of a female, aged forty, of the size of a hen's egg, and followed a blow. Excision; recovery. (Lancet, vol. i. 1861, p. 264.)

26. *Fibrous* tumour of *trapezius*. It occurred in a female, aged fifty-five, was of nine months' duration, and was excised. A previous growth had been removed. (Mus. R. C. S., 222 *a.*)

27. *Fibrous* tumour from the *vastus internus*. (Bull. de la Soc. Anat. de Paris, vol. xix. p. 78.)

28. *Fibrous* tumour in a muscle not named. (Mus. St. Barth. Hosp., No. 305.)

29. *Fibro-adipose* tumour in the *pectoralis major* of a male, aged twenty-nine, was as large as an orange, of four years' duration, and was excised. (Lancet, vol. 1857, p. 186.)

30. *Fibro-adipose* tumour in the *biceps humeri* of a man, aged nineteen. The growth, which was four ounces in weight, and of one year's duration, was excised, and followed by recovery. (Lancet, vol. i. 1854, p. 518.)

31. *Fibro-plastic* tumour in the *pectoralis major* of a male, aged twenty-three. It was as large as a fœtal head, of six months' duration, and was excised with nearly all the muscle. Two years later it recurred. (L'Union Médicale, Août 29, 1861.)

32. *Fibro-plastic* tumour, with osseous wall, in the *lastissimus dorsi* of a young woman. It was excised, and patient recovered. (L'Union Médicale, Nov. 10, 1861.)

33. *Fibro-cartilaginous* tumour in the *semi-membranosus* of a boy, aged fourteen. It was of the size of a fist, and was excised. (Holmes' Surgery, vol. iii. p. 539.)

34. *Fibro-cartilaginous* tumour in the *deltoïd* of a young man. It was the size of an egg, and was excised. (Holmes' Surgery, vol. iii. p. 539.)

35. *Recurrent fibroïd* tumour in the *masseter* of a man. It was as large as a walnut, of four months' duration, and was excised. (Holmes' Surgery, vol. iii. p. 540.)

36. *Fibro-nucleated* tumour in the *rectus abdominis* of a male, aged twenty-seven, of the size of a turkey's egg, and supposed to have been caused by an injury. Excision; recovery. (Med. Times, vol. xxxii. p. 321.)

37. A tumour described as *albumino-sarcoma* in the *triceps humeri* of a boy, aged twelve; was as large as half an orange, of three years' duration, and was excised. (Med. Times, vol. xxxiii. p. 211.)

38. *Myeloïd* tumour in the *deltoïd* of a female, aged twenty-seven, of great size, and two years' duration. The entire muscle, with the acromion and scapular extremity of the clavicle, was excised. Recovery. (Med. Times, vol. xxxiii. p. 334.)

39. A *cyst* in the *biceps humeri* of a female, aged twenty, as large as a walnut. (Holmes' System of Surgery, vol. iii. p. 540.)

40. *Cysts* in the *biceps humeri* of a female, aged twenty-two. Were cut open, and allowed to suppurate. (Lancet, vol. ii. 1859, p. 662.)

41. A *serous cyst* excised from the *gluteus maximus*. (St. George's Hosp. Mus., Series 45.)

42. A *serous cyst* in the *rectus abdominis*. During lifetime the tumour was supposed to be a chronic abscess. (Lond. Med. Gaz., vol. xli. p. 217.)

43. A *cyst* in the *pectoral* muscle. (St. Barth. Hosp. Mus., No. 202.)

44. A *sanguineous cyst* in the *gastrocnemius* of a male, aged thirty-three. It contained half a pint of blood, and was of long duration. (Trans. Path. Soc., vol. viii. p. 363.)

45. A *cystic* tumour in the *adductor magnus* of a boy, aged four-

teen. It was as large as the adult head, and of nearly two years' duration. Excision of part, followed by death in forty-eight hours. (Lancet, vol. i. 1856. p. 371.)

46. A *cyst* in the *sartorius*, containing cretaceous matter. (Bull. de la Soc. Anat de Paris, vol. for 1859, p. 10.)

47. A *hydatid* tumour in the *biceps humeri*. (L'Union Médicale, Août 31, 1861.)

48. A large *acephalocyst hydatid* in the *gluteus maximus* of a female, aged forty. It was of five years' duration, was excised, and patient recovered. (Mus. R. C. S., No. 345.)

49. A *hydatid* cyst in the *rectus abdominis* of a man. (Comptes Rendus de la Soc. de Biol., vol. for 1852, p. 6.)

50. A *hydatid* in *rectus abdominis*. (Mus. R. C. S., No. 597.)

51. A small *hydatid* tumour in the *deltoïd* of a man, aged seventy. It was the size of a walnut, and of six months' duration. (Gross' Surgery, vol. i. p. 747.)

52. *Erectile* tumour in the *semi-membranosus* of a male aged ten, of eight years' duration. Excision; recovery. (Med.-Chir. Soc. Trans., vol. for 1843, p. 120.)

53. *Erectile* tumour in the *external oblique*. It was of congenital origin, and was excised, (Med. Times, vol. xxxii. p. 321.)

54. *Erectile* tumour in the *supinator longus* of a female, aged twenty-eight. It was of nine years' duration, and was excised. Recovery. (L'Union Médicale, Dec. 26, 1861.)

55. *Erectile* tumour in the *semi-tendinosus* of a female, aged seventeen. Excised. (St. Barth. Hosp. Mus., No. 118.)

56. *Erectile* tumour in the *sterno-mastoïd*. The growth was of four years' duration, and as large as a turnip. Its excision was followed by recovery. (Med.-Chir. Soc. Trans., vol. for 1843, p. 128.)

57. An *osseous* tumour in the *adductor longus*. (Bull. de la Soc. Anat. de Paris, vol. xv. p. 396.)

58. An *osteo-calcareous* growth in the *extensor communis digitorum*. (Bull. de la Soc. Anat. de Paris, vol. xxiii. p. 15.)

59. An *osseous* tumour in the *rectus femoris* of a male, aged fifty-six. Death from cancer of the stomach. (Bull. de la Soc. Anat. de Paris, vol. xxx. p. 3.)

60. Tumour, described as *muscular*, in the *sterno-mastoïd* of an old woman, and supposed to have been caused by a blow. It would appear to have been a cyst. (Lancet, vol. ii. 1861, p. 349.)

61. Tumour, described as *muscular*, in the *masseter* of a man, aged thirty-five. Excision; recovery. (Med. Times, vol. xxxiv. p. 243.)

62. Tumour, described as *innocent*, in the *sartorius* of a female. Excision; recovery. (Amer. Med. Jour., April, 1853, p. 363.)

It will thus be seen that out of 62 cases the relative numbers of each growth were—cancerous, 21; fibrous, alone and in combination, 16; cystic, 8; hydatid, 5; erectile, 5; osseous and osteoïd, 3; doubtful nature, 3; myeloïd, 1. The cancerous tumours were the most numerous, being rather more than one-third of the whole; but, from an examination of the other cases that I have excluded, I am convinced that their proportion is very much greater than this. It would also appear that the tumours affected the muscles of the lower extremity almost as often as they do those of the upper limb; but with this difference, that in the latter they are almost entirely confined to the pectoralis major, deltoïd, and biceps, whereas in the former they are very equally distributed. The muscles of the trunk, and head, and neck were rarely the seat of tumours, with the exception of the rectus abdominalis, which would appear very subject to them.

The above facts are somewhat opposed to the opinions of the authors already named; for Gross states that he had only seen one case of hydatids, that melanosis may occur, but that encephaloïd, colloïd, and scirrhus are very rare. Tatum thinks the fibrous tumour is the most frequent, that encephaloïd may exist, but that scirrhus seldom obtains. Rokitansky is of opinion that cysts, with the exception of those that enclose entozoa, are very rare, that bony growths not unfrequently exist, but that cancerous formations are extremely uncommon. Chevalier was not aware of any case of hydatids in the voluntary muscles, and thought that cancer never began in them. Erectile tumours must be exceedingly rare. I have only been able to meet with three cases, in addition to the two described by Liston,* who states, in reference to one of them, "The author is not aware of its having been found in muscular substance. In the preceding case, however, it is more than probable that a small mass of erectile tissue had originally existed in the muscle, and had gradually become developed, till, at two years of age, it attained such a size as to attract attention." Rokitansky mentions that a growth composed of true bone is often found in the left deltoïd muscle of recruits, and hence named the drilling bone. I believe the earliest recorded case is to be found in the 'Journal der Chirurgie und Augen-Heilkunde,' for 1830, p. 141. This curious pathological specimen does not seem to have been observed in this country.

It is a remarkable fact, that lipoma, which is so frequent in the subcutaneous cellular tissue, has never as yet, I believe, been found in the interfibrillar connective tissue. Parmentier is, I think, the only author who has pointed out this singularity, and he goes so far as to say that, when diagnosing a tumour in a muscle, we may entirely discard the chance of its being lipomatous.

Is there any such growth in the voluntary muscles composed of striped fibre which would merit being called a true "muscular tumour"? In the prostate and uterus there are, without doubt, new formations made up of unstriped fibres, but I have not been able to meet with any case to which the above name could be applied. The few that I have met with described as muscular admit of great doubt. Paget states,† "I have not, indeed, seen such a specimen as would quite justify the name of 'muscular tumour,' assigned by Vogel." Still, I think there is no reason why it should not exist, for Rokitansky has

* Trans. of Med.-Chir. Soc., vol. for 1843, p. 127.
† Paget's Surgical Pathology, p. 476.

met with transversely-striated cells in a tumour of the testis, and both Virchow and Kölliker have discovered "elongated, fusiform, transversely-striated cells" in an ovarian tumour. Virchow* expressly states that, in pathological formations, "those elements are most rarely imitated which belong to the more highly organized, and especially to the muscular and nervous systems. Still, these formations are by no means excluded; we find pathological new formations of every description, no matter to what tissue they may be analogous, provided it possess distinctive features. It is only with regard to their frequency and importance that a difference prevails."

Most writers are of opinion that the muscular system is only secondarily affected with cancer. Paget† states, "I have never seen a primary scirrhus cancer in a muscle." According to Rokitansky,‡ "in whatever form this disease presents itself, it is scarcely ever the primary cancerous affection in any muscle of animal life except the tongue. One or more cancerous growths are almost always found elsewhere, and that in the muscular system is the secondary affection." Walshe,§ however, inclines to an opposite belief. "Bayle states that the muscles of locomotion are not observed to be affected with primary cancer, in which respect they differ from those of organic life. The fasciculi of Cruveilhier, however, prove that small cancerous masses may be developed secondarily in the muscles of animal life, without any direct continuity with the original disease; and I have myself seen primary encephaloïd infiltration of muscular substance." He is also of opinion that primary scirrhus may likewise occur. I think there can be no doubt that medullary cancer may exist in muscles as a primary growth or infiltration. Most of the cases of encephaloïd that I have enumerated were primary cancers, and three of them were proved post-mortem to have been such. Primary scirrhus, however, must be excessively rare. I have only been able to meet with two cases of it, and they are both exceedingly doubtful. The preparation in the Museum of the College of Surgeons of a pectoral muscle, with several small, "oval, hard, and white" carcinomatous tumours in it, is, in all probability, an instance of that muscle secondarily affected in scirrhus of the breast.

Whence do tumours in muscle arise—from the fibril or the interfibrillar connective tissue? It would seem to have been the opinions of most writers that they arose in the interstitial connective tissue.

Gross‖ expressed the general belief when he wrote: "The probability is that none of these heteroclite formations are developed in the muscular substance, properly so called, but that they begin in the interfibrillar tissue, from which, as they increase in size, they gradually encroach upon the fleshy fibres, which they thus displace, alter, or destroy." There can, I think, be no doubt that the non-malignant tumours originate in the interfibrillar tissue. The microscopical examinations of cases would seem entirely to point that way; and fibrous tumours can often be demonstrated as arising in the interstitial tissue,

* Cellular Pathology, p. 63.
† Op. cit. p. 608.
‡ Op. cit. p. 317.
§ Walshe on Cancer, p. 97.
‖ Op. cit. vol. i. p. 748.

the muscular fibrils being wholly intact. Regarding the occurrence of cancer in muscle, it used also generally to be maintained that it had its origin in the same connective tissue. However, Cruveilhier and Lebert were the first, I believe, to point out that it sometimes arose in the fibril itself. They both brought forward cases in which they had discovered cancer "dans l'intérieure des cylindres musculaires;" and, in the last edition of Paget's work, it is stated that Weber, Neumann, and Turner have all demonstrated the development of cancer-cells in muscular fibril. It thus appears that cancer may commence either in the interfibrillar tissue or in the fibril, and that it may affect the latter as a distinct tumour, or as an infiltration, or as a degeneration, merely replacing the fibril, and not causing any alteration in the shape of the muscle. However, the fibril is far more likely to be diseased than the connective tissue, as is proved by the fact of the latter so often remaining wholly unaltered in fatty and cancerous degenerations of muscle, and the sheath of the muscle is the last to give way to disease, for nothing is more remarkable than the fact that in psoas abscess of many years' duration the sheath will be often found strong and resistant, and perhaps greatly thickened. It would, indeed, seem to be a conservative provision of nature, for it is very rare to find that pus has escaped into the abdomen. The sheath would seem to have fulfilled the office of a sewer, and to have conducted the pus to a point whence it might be harmlessly discharged. These facts, as will hereafter be seen, have a most important bearing.

Regarding the treatment of tumours in muscles. I desire to draw attention to two important points. Firstly, there is a class of swellings in muscles, the result of constitutional syphilis, which may simulate other growths, and so lead to probable error in diagnosis. It would seem that this description of tumour is very much more common than is perhaps supposed, for since attention was drawn to this point numerous cases have been, and constantly are being, recorded; and, when its cause is kept in mind, it is quite sufficient to put us on our guard lest a given tumour that we may happen to meet with be of this nature, and to remember always, though there may be no evidence nor history of syphilis, yet that its effects may make themselves manifest, from time to time, when the constitutional taint may long since have faded away.

The greatest experience, and the most consummate diagnostic tact, will sometimes fail to discriminate softer forms of encephaloïd tumours from syphilitic swellings, when the skin is intact; and when we consider that operations have often been needlessly performed for growths supposed to be cancerous, but which turned out to be syphilitic, we cannot be too careful lest we also commit like errors. These swellings had long ago been observed by Astruc; and in Casper's 'Wochenschrift' for 1845, a tumour in the sterno-mastoïd was described which created considerable interest. In the same year also, Mr. Tatum read a paper at the Medico-Chirurgical Society, entitled, "Three Cases of hard circumscribed Tumours in Muscle disappearing under the influence of Iodide of Potassium;" and Nélaton states, that although he had

himself often observed these swellings before Bouisson wrote, yet that to the latter must be ascribed the merit of having been the first to clearly point out their pathology and treatment in the 'Gazette Médicale' for 1846. Bouisson was not the first, however, to cure tumours with iodide of potash, for in 1836 Dr. Andrew Buchanan, then surgeon to the Glasgow Royal Infirmary, wrote a paper on the use of the drug for their absorption, and recorded that, by administering the medicine internally, he had cured a case in which the growth was situated in the calf of a woman's leg, although some surgeons had previously condemned the limb to be amputated. In 1839, Robert described a similar case. It is therefore of the greatest utility in doubtful tumours to administer this remedy for a few weeks, for it will either cure the disease or greatly facilitate the diagnosis. In most instances the delay of a few weeks can make but little difference; and it is well not to take imaginary evils into calculation. Some surgeons have great objection to make an exploratory puncture, but I think the great and valuable evidence so often afforded by it far outweighs any disadvantage attending it. A cold abscess with thick walls, when seated in the body of a muscle, will often puzzle an able surgeon. Bérard once cut down on to an abscess in the biceps, thinking that it was a solid growth. It is well known that the diagnosis between cancer and syphilis, when seated in the tongue or lip, is often by no means easy. When syphilitic swellings first form in the muscles they are generally fluid, and, if punctured, will at once subside, but if they have passed from the stage of induration to that of ulceration, they may very much resemble a malignant tumour which has eaten through the skin. I think, therefore, that the exploring-needle and iodide of potash will be found useful auxiliaries in cases of difficult diagnosis.

Secondly, what operation, if any, ought to be performed for a cancerous tumour in a muscle?

Surgeons generally extirpate innocent tumours seated in the soft parts of the limbs, and not involving the bones. I think, however, when the tumour is very large, has deep connexions, or is situated in the thigh, that the practice is very questionable. On looking over the records of cases for some years past, I find there have been many instances of large innocent tumours in the thigh, especially in the inner side. They have generally been excised, and recovery from the operation has been quite the exception. Occurring, as they usually do, in young healthy subjects, the great mortality is still more remarkable. Some of the French surgeons have found the above line of treatment so uniformly fatal in their own practice for similar cases, that they have been led to adopt a different course, and I think their opinions are worthy of serious consideration. I believe the reasons for the great mortality are to be found in the facts of a prolonged dissection (often violent), the production of an enormous wound (often lacerated in its deeper parts), and the necessarily lengthened period that it is requisite to keep the patient under chloroform. Now in amputation the opposite conditions obtain. Sanson and Robert* are both of opinion, that in these cases amputation is preferable to excision. "M. Robert se rapelle avoir observé plusieurs cas de ce genre. Les tumeurs occupaient toute la partie moyenne et interne de la cuisse, elles ne paraissaient pas adhérer aux os. Quatre fois il fit l'extirpation et quatre fois la mort s'ensuivit. La première malade était couchée à la Pitié dans le service de Sanson. Ce chirugien, instruit déjà par des cas observés auparavant, proposait la desarticulation coxo-fémorale plutôt que l'extirpation, qu'il considérait comme nécessairement mortelle. . . . . En resumé, M. Robert aujourd'hui conseillerait plutôt l'amputation que l'ablation qui donne naissance ä une plaie beaucoup plus grave." Maisonneuve extirpated the calf of the leg for a large tumour in it; the operation was fatal, and called forth the following remarks from Lepelletier, who witnessed and recorded the case:—"Après ce resultat il est permis de se demander si l'amputation de la cuisse n'aurait pas presenté plus de chances de succés. Telle est mon opinion; et peut-être M. Maisonneuve hésiterait-il à pratiquer de nouveau cette opération dans un cas semblable. Je ne crois pas que le désir de conserver un membre aussi important que la cuisse autorise une opération dont les suites peuvent ètre plus graves que celles de l'amputation. Si on considére en effet, l'étendue et la profondeur de la plaie produite par l'extirpation, on comprendra facilement à combien d'accidens graves la malade était exposée. Les suites de cette opération l'ont prouvé."

Chassaignac and Verneuil are also in favour of amputating rather than excising in these instances.

Not long ago, it was a doubtful point whether life were prolonged by operating in cases of cancer. Now, however, I think the matter must be considered to be set at rest by Mr. Sibley's and Mr. Baker's statistics, which clearly shew the increased average duration of life that is gained by operating. It is therefore the surgeon's duty to operate, unless, in a particular case, some condition or fact forbid it.

No doubt from year to year the belief of the profession will oscillate between the local and constitutional origin of cancer till the question is finally settled. At present, however, the opinion would seem to be strongly setting in favour of the belief that cancer is a local disease, and Dr. Wilks states that it has a majority of evidence on its side. The teachings of such men as Virchow and Hughes Bennett will tend strongly to strengthen this view, which is certainly the more utilitarian of the two, for who would devote his time and energies to find out a cure for the incurable? The *onus probandi* of the entire controversy clearly rests with those who assert that a cancer is a constitutional disease, and, until such affirmation be proved, no surgeon is justified in its belief.

What operation, then, ought to be performed for a cancerous tumour in a muscle? On searching the works of past surgeons, I come to the conclusion, that in cases of malignant disease affecting the soft parts of limbs, they generally amputated. If, however the present English

* Gazette des Hôpitaux, June 28, 1856.

surgical works be examined, it will be found that, in nearly all, no directions whatever are laid down as to what kind of operation is to be done in the above cases. Those that make any allusion to the subject, recommend the disease to be thoroughly cut out; one author only states that, "In the limbs, as a general rule, amputation is preferable to a local, which is often necessarily a partial, extirpation." The American surgeon is, however, very clear on this point. "A valuable rule in tumours is to excise the benign and to get rid of the malignant by amputation;"* and, "when the disease is seated in an extremity, especially the distal portion, the proper operation is amputation, not excision."†

I find, from an examination of the different journals for many years past, that surgeons generally excised cancerous disease when seated in the soft parts of limbs, and not involving the bones, and unvaryingly so when the skin was intact and the tumour had no deep connexions. They seemed to have been actuated by the very landable desire of preserving the limb, and to have founded their treatment on the same principle as that followed in a cancerous breast.

I shall now endeavour to show, that any operation, for the removal of a cancerous tumour in a muscle, which takes away the growth and leaves behind that structure in which the disease commenced is wrong in principle and contradicted by analogy.

If a malignant growth, however small, affected the mammary gland, no surgeon would ever think of excising that part of it which seemed diseased, leaving behind that which was apparently healthy; he would be content with nothing less than the excision of the entire breast; and if a tumour of the same nature affected the lower part of the femur, he would not amputate through that bone, but would disarticulate the limb at the hip-joint; in each case removing the whole of that structure in which the disease originated and was situated.

Why, therefore, should a surgeon cut a cancerous tumour out of a muscle, and leave behind the structure in which it commenced? It is clearly wrong; a malignantly affected structure ought always to be cut out and not cut through. The following observations apply almost verbatim to the subject: "Still, the ascertained fact of the encephaloïd tumour being occasionally combined with unsoundness of bone to an indefinite extent, is sufficient to warrant the rule, that in such cases the amputation should, if possible, be performed not through the bone in which the disease originated, but either through the contiguous joint or above it."‡

Sir B. Brodie§ states: "It is to be observed, that in this instance the whole of the humerus—that is, the whole of the organ in which the disease was situated—was removed. It is probable that the success of the operation in such cases depends mainly on that circumstance." And further on‖ he remarks: "I have no sufficient evidence to offer

* Op. cit. vol. i. p. 621. † Op. cit. p. 329.
‡ Stanley on Diseases of Bone, p. 174.
§ Diseases of the Joints, p. 273. ‖ Ibid. p. 278.

in favour of an operation performed for the removal of a joint affected with malignant disease, in which a portion of the bone in which the disease has originated, is allowed to remain. Cases may have occurred in which there was no recurrence of the disease under these circumstances; but there has been no such favourable result in any of those in which I have had the opportunity of learning the patient's history afterwards; and, as I have already observed, it is not what our experience of the effects of operation performed for malignant diseases in other organs would lead us to expect. I confess that it seems to me that the rule of practice is sufficiently obvious; though there may be some difficulty in the application of it to individual cases, on account of our having no certain marks by which we may at all times, and in every instance, distinguish diseases which are malignant, and diseases which are not malignant, from each other."

If it be asked, why cancer so often returns after operation, I think the answer is to be sought for, not in an hypothesis, but in the material and visible fact that a cancer is generally cut out of cancerously diseased structures, and hence a return of the growth is only an exemplification of natural processes. It rarely happens, that when a malignant tumour is brought under the surgeon's notice that it is confined to the structure or part in which it originated, and as the most frequent operation for cancer is the excision of the breast, and as that procedure must be called an imperfect operation on account of the surgeon being limited in his incisions I believe, that where we can find a cancer confined to, and isolated in one given structure that is capable of being thoroughly excised *en masse*, we have every reason to hope for better results than have been attained in operations on cancerous breasts.

Now, when a cancer is seated in a muscle there are two important facts to be remembered. The muscle is as obnoxious to disease as its sheath is resistant to the spread of malignancy. Miller has pointed out that dense fibrous tissue resists the invasion of carcinoma longer than any other texture; and Virchow expressly states that it is very little disposed to become diseased by contagion, whereas the soft structure of muscle is well adapted for the conveyance of cancerous juices, and hence likely to encourage the formation of new foci of disease. When once a cancer has commenced in a muscle, there is every condition present to favour the transmission of its juices from one end to the other. Independently of all physiological action, I believe that capillary attraction, gravitation, and muscular action are all, more or less, capable of diffusing the elements of the disease. On the other hand, the sheath can for a long time serve as a barrier against the infiltrating fluids, and so protect the surrounding parts. If, when the cancerous tumour is still confined within the sheath, we excise the entire muscle, we may reasonably believe that we have thoroughly enucleated the disease.

When the growth is in the rectus abdominis muscle, and adherent to the peritoneum, I would recommend Parmentier's advice,* and it

* L'Union Médicale, Août 31, 1861.

must be remembered that the above muscle is practically several muscles: "Enfin, s'il s'agissait d'une tumeur développée dans le grand droit de l'abdomen, et offrant quelque adhérence avec le péritoine, il ne faudrait pas hésiter, contre l'avis de Boyer, à achever l'opération, car il vaut mieux avoir affaire à une plaie pénétrante de l'abdomen que de laisser dans l'économie un produit qui fatalement causera la mort du malade."

Therefore, whenever practicable, a cancerous tumour in a muscle should not only be excised, but the muscle in which it originated ought to be cut out from its origin to its insertion. But if the cancer be of large size, or if the skin be affected, or if the wound resulting from the excision of the muscle would be of great extent, then the limb ought to be amputated, and the remainder of the muscle in the stump excised.

I have thus ventured to propose an operation which is founded on definite principles, is supported by analogy, and is in unison with the views of some of the most original thinkers of our time.

Henry Mitchener, Machine Printer, 26, Eversholt Street, Oakley Square, Camden Town, N.W.

OBSERVATIONS

ON

STERILITY IN MAN.

WITH CASES.

BY

T. B. CURLING, F.R.S.,

SURGEON TO THE LONDON HOSPITAL, ETC.

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OBSERVATIONS

ON

STERILITY IN MAN.

STERILITY is a condition which has usually been restricted in its application to the female, or in the male has been confounded with impotency; and until recently our knowledge of the impaired functions of the male reproductive organs has not warranted any distinction being drawn between an incapacity for sexual intercourse and an inability to procreate. The object of this paper is to show that a want of aptitude to impregnate may co-exist with the capacity for sexual intercourse; or, in other words, that man is subject to *sterility*, independently of *impotency*. The subject is not altogether new, MM. Gosselin, Follin, Godard, and others, having published some important facts in relation to it, but opportunities of making the necessary inquiries are extremely rare; and as doubt exists of the soundness of the conclusions which have been arrived at, facts of a contradictory character having been adduced, I have been led to examine the question, and my practice has enabled me to collect some interesting observations bearing upon it. The importance of the subject, as respects the happiness and results of married life, must be my apology for giving details, the recital of which could not be avoided.

Sterility in man may arise from the following causes:—

1. Malposition of the testicles. 2. Obstructions in the excretory ducts of the testicles. 3. Impediments to the escape of the seminal fluid.

1. *Sterility from Malposition of the Testicles.*—The opinion of John Hunter, "that when one or both testicles remain through life in the belly, they are exceedingly imperfect, and probably incapable of performing their natural functions," has been the subject of much comment, and in my work on 'Diseases of the Testis' I expressed my adhesion to the views of Professor Owen, who, in differing from Mr. Hunter, remarks, that there is nothing in such a situation which necessarily tends to impair the efficiency of the testicles, since in many animals they constantly form part of the abdominal viscera; and in those in which the testes naturally pass into the scrotum, their continuance in the abdomen is accompanied only with a difference of size or shape. Now, we may readily suppose that this may influence the quantity, but not necessarily the quality of the secretion. The facts which I am about to adduce have corroborated Mr. Hunter's opinion in a remarkable manner, and have led me entirely to change my own views on the point in question.

That a cryptorchic person, or a man with both testicles in the abdomen or in the groin, may have a masculine development, passion for women, and the power to copulate, is beyond question, being satisfactorily established by several well-authenticated instances, although there have been many cases in which such persons were impotent, and had not fully exhibited the external characters of the male sex. When the testicle has not passed into the scrotum, the gland is nearly always small in size; generally it is healthy, but undeveloped; that is to say, it has not undergone the enlargement and change in structure which take place at puberty. In some instances, especially when seated in the inguinal canal, it is withered and atrophied, having undergone fibrous and more rarely fatty degeneration, and exhibiting no trace of glandular structure. But the question to be considered is, whether a testicle which has not passed into the scrotum can secrete a fertilizing fluid—a fluid which, when emitted in sexual intercourse, is capable of impregnating the female. I assume, as quite established, that to possess this property the semen must contain zoosperms.

Professor Goubaux, a distinguished French veterinary surgeon, was the first who noticed in horses, not only that the testicles detained in the abdomen were soft and small in size, but that the fluid in the corresponding vesiculæ seminales was destitute of spermatozoa. In 1851 M. Follin briefly alluded to three instances of detained testicle on one side in the human subject, in which he found the fluid in the vesicula seminalis of the same side destitute of spermatozoa, though they were present on the other side.[1] In 1855 I described[2] the examination of a man aged thirty-six, whose right testicle was in the abdomen, small and undeveloped. There were no spermatozoa in the efferent ducts nor in the right vesicula seminalis, but the left contained them in abundance. In 1856 Messrs. Goubaux and Follin, in a joint memoir, 'Sur la Cryptorchidie chez l'homme et les principaux Animaux Domestiques,' read at the Société de Biologie, adduced several instances in man and animals in which testicles remaining in the abdomen were small, and did not secrete sperm. They furnished also a few examples of animals which, though possessing the desire and power to copulate, were quite sterile. The late M. Godard, in a memoir read at the Société de Biologie on the same evening as the above, mentioned the cases of three cryptorchic married men who had no children, and affirmed that such persons were always sterile. This earnest and indefatigable pathologist, whose recent death is a loss to medical science, in a more recent work, supported this opinion by additional facts, to which I shall have occasion to refer. The proofs adduced, however, by these observers, were not sufficiently cogent and numerous to establish the law that cryptorchics are infertile; and it could not be expected that assent should be given to results so remarkable and unexpected without evidence of the most convincing character. Opposite opinions continue to be entertained, and Dr. Taylor, in the last edition (1861) of his work on Medical Jurisprudence, after briefly noticing some recent observations on this subject, states that when the power of sexual intercourse exists, "this imperfection does not offer any bar to marriage, nor is it a ground for divorce." Casper also remarks, more recently, "Experience proves that crypsorchides are perfectly capable of procre-

[1] Archives Générales de Médecine, 4e Série, t. xxvi. p. 265.
[2] Diseases of Testis, 2nd edit., p. 27.

ation, and there are, *à priori*, no physiological reasons for doubting this."[1]

Case I.—In 1859 a gentleman, aged thirty-eight, consulted me under the following circumstances:—His testicles had never properly descended into the scrotum, and though not deficient in copulative powers, he had been married eleven years without his wife becoming pregnant. He was desirous of knowing whether this was owing to any fault in himself. In external development, this gentleman had all the attributes of the male sex. On examination, I found his penis normal, and his testicles small in size, the right being less than the left. Both were lodged in the groin, just outside the outer ring. The right could be easily pressed up into the inguinal canal, through rather a large external ring. Pressure on the left caused it to recede into the upper part of the thigh, just below Poupart's ligament, where the integuments were loose. When the left testicle became thus displaced, which occurred occasionally, the patient felt uneasiness, referred to the navel. The scrotum was small and imperfectly developed; the left testicle could be depressed into it by a little force. He stated that he performed the sexual functions about twice weekly, and when younger had done so more frequently. The fluid emitted in intercourse was carefully examined by myself and Dr. Andrew Clark separately, on three occasions, at intervals of about a week. It was found to be entirely destitute of spermatozoa. With the view of forcing the left testicle into the scrotum, and retaining it there, I recommended his wearing the moc-main lever truss, but this treatment was not persevered in.

Case II.—In 1852 I was requested to see an inmate of a charitable asylum, a youth, aged eleven, whose testicles had not passed into the scrotum. The right was lodged just outside the external ring; the left was not discernible at all. He had no scrotum. In 1861, at the age of twenty-one, he again came under my notice. He was rather short in stature, but had a masculine development. He wore a moustache, and had abundance of hair on the pubes. His penis was rather large. He held a clerk's situation in the city, and had been married twelve months. He stated that he had frequent intercourse with his wife, followed by ejaculations. She had not become pregnant. Some fluid obtained from the urethra immediately after sexual intercourse was sent me on two occasions, the second being after an interval of eighteen months. It was carefully examined by myself and others, and found to be destitute of spermatozoa.

Case III.—In April, 1861, I saw with Mr. Duchesne, of Woodford, a gentleman, aged forty-six, a married man, who had serious disease of the left testicle, which had commenced about a month previously. The gland, being quite disorganized, was removed by me on the 22nd. The wound healed favourably. During my attendance I noticed that the right testicle had not emerged from the abdomen. After his recovery, and quite two months after the operation, he had intercourse with his wife. The fluid emitted was examined, but no spermatozoa could be discovered in it.

Case IV.—In March, 1863, I was consulted on the propriety of

[1] Handbook of Forensic Medicine. Translated by Balfour. New Sydenham Society. 1864.

marriage under the following circumstances:—A gentleman, thirty-nine years of age, stated that about fourteen years ago he was in the habit of frequent sexual intercourse, when one night after connexion the left

TABLE I.

No.	Age.	Position of Testicles.	Sexual Condition.	State of Ejaculated Semen.	Authority.
1	38	. . Both in the groin, outside the abdominal rings.	. . Married eleven years; copulative powers satisfactory; no children.	. . Destitute of spermatozoa; examined three times.	. . Curling. Case I.
2	21	. . Right, outside abdominal ring; left, within the abdomen.	. . Married two years; powers satisfactory; wife had not become pregnant.	. . Destitute of spermatozoa; examined twice at an interval of eighteen months.	. . Curling. Case II.
3	46	. . Right, in the abdomen; left, removed by operation.	. . Married; powers satisfactory; no child.	. . Destitute of spermatozoa; examined once.	. . Curling. Case III.
4	39	. . Right, outside inguinal canal; left, completely atrophied.	. . Single; powers satisfactory . .	. . Destitute of spermatozoa; examined twice.	. . Curling. Case IV.
5	44	. . Left, outside inguinal canal; right, in the scrotum, but epididymis obstructed after orchitis.	. . Married; competent, but weak.	. . Destitute of spermatozoa; examined once.	. . Godard: Études sur la Monorchidie et la Cryptorchidie, p. 103.
6	22	. . One in iliac fossa; the other in inguinal canal.	. . Single	. . Destitute of spermatozoa; examined several times.	. . Godard: Ibid., p. 147.
7	24	. . Both in the abdomen.	. . Single; had contracted gonorrhœa.	. . Destitute of spermatozoa; examined three times.	. . Godard: Ibid.
8	Not stated.	. . Both in the inguinal canal.	. . Married; powers satisfactory . .	. . Destitute of spermatozoa; examined several times.	. . Puech: Gazette Hebdom., Dec. 1856.
9	24	. . Both in the abdomen.	. . Single; had desires, erections, and emissions.	. . Destitute of spermatozoa; examined four times.	. . Partridge: Path. Trans., vol. ii.

testicle was attacked with violent inflammation, which was followed by a gradual wasting of the gland. The right testicle was small and had

not fairly passed into the scrotum. The sexual appetite was keen, and coition was effected with ease, the emission being fairly copious. My patient was healthy and moderately robust. The left testicle was reduced to the size of a pea; the right was properly formed and tolerably firm, but quite small, like an undeveloped testicle before puberty. Some fluid emitted in sexual intercourse was sent me on two occasions. In both instances it was thin and destitute of spermatozoa. I consequently gave an opinion adverse to his marrying, on the ground that he was unfit to procreate—that his wife would be barren.

In Table I. I have added to these four cases five others, well authenticated, in which the fluid ejaculated by men with retained testicles was submitted to examination and found to be wanting in spermatozoa.

In confirmation of the results obtained in these cases, I may adduce some interesting observations made upon the lower animals. The following are related in Messrs. Goubaux and Follin's 'Memoir.'—A horse, twelve years of age, though presenting all the characters of an entire horse, bore the well-known marks of castration on the right side, but on the left side there was no trace of cicatrix, and no scrotal sac or testicle. Erections were manifested in the vicinity of mares. After covering one, the fluid emitted from the urethra was examined and found to be destitute of spermatozoa.—After the purchase of a horse six years old, a question arose between the buyer and vendor whether the animal could be used as a stallion. The veterinary surgeon could discover no testicles, although the skin of the region presented no marks of the animal having been castrated. In presence of a mare the horse manifested undoubted signs of the influence of the approach. He was allowed to cover her, but accomplished the act with more difficulty, and especially slowness, than usual with a vigorous stallion of the age. The examination of the fluid emitted on three occasions, at intervals of several days, afforded no trace of spermatozoa.[1] M. Godard relates[2] that a cryptorchic dog covered a bitch in heat four different times in March, 1856. The fluid ejaculated on each occasion was found destitute of spermatozoa. In February, 1857, the same dog, who was addicted to coition, again covered the bitch, and the sperm emitted was also found to contain no zoosperms.

I have already alluded to a few instances in which the fluid found after death in the substance of a retained testicle, in the epididymis or vas deferens, or in the vesicula seminalis on the side corresponding to the malplaced gland, has been examined and found destitute of spermatozoa. Many other examinations have been made. They are collected in Table II. (following page), which includes three observations of my own. Spermatozoa have not been discovered after death in the spermatic ways of a detained testicle in any one instance that I know of.

Gosselin and Godard make mention of several instances of cryptorchics who were married but had no children; and I know of another instance in addition to those related in this paper. Though it is most

[1] Professor Spooner, of the Veterinary College, informs me that he has examined several testes taken from the abdomen of horses after death, and in all of them the gland was small in size, and without spermatozoa.

[2] Ibid., p. 147.

probable that in all these cases barrenness was owing to the absence of a fecundating property in the semen, yet, as it was not examined

TABLE II.

No.	Age.	Cause of Death.	Position of the Testicles.	Condition of Malposed Testicle.	State of Seminal Fluid.	Authority.
1	36	. . Recent injury.	. . Right, within the abdomen; left, in the scrotum.	. . Healthy, but undeveloped; weight, 110 grs.	. . No spermatozoa in right vesicula seminalis, and ducts of right testicle.	. . Curling: Diseases of Testis, 2nd edition.
2	27	. . Intestinal obstruction.	. . Left, outside abdominal ring; right, in the scrotum.	. . Small and undeveloped.	. . Spermatozoa in left vesicula seminalis; no spermatozoa in left vas deferens and vesicula.	. . Curling: Patholog. Trans., vol. ix.
3	25	. . Disease of the heart.	. . Right, in the inguinal canal; left, in the scrotum.	. . Healthy, but small; weight, 132 grains.	. . Spermatozoa in right vesicula seminalis; no spermatozoa in right vas deferens and vesicula; spermatozoa in abundance in left vas deferens and vesicula.	. . Curling: Patholog. Trans., vol. xii.
4	24	. Recent injury.	. . Right, within the abdomen; left, in the scrotum.	. . Healthy, but small.	. . No spermatozoa in right testicle, epididymis, vas deferens, and vesicula seminalis; spermatozoa in left epididymis, vas deferens, and vesicula.	. . Godard: Études sur la Monorchidie et Cryptorchidie, p. 54.
5	26	. . Meningitis.	. . Right, in the inguinal canal; left, in the scrotum.	. . Healthy, but small.	. . No spermatozoa in right vesicula seminalis; spermatozoa in left vesicula.	. . Godard: Ibid., p. 61.
6	50	. . Strangulated hernia.	. . Both outside abdominal rings.	. . Healthy.	. . No spermatozoa in the testicles, vasa deferentia, and vesiculæ.	. . Godard: Ibid., p. 124.
7	30	. . Peritonitis.	. . Both in inguinal canals.	. . Healthy.	. . No spermatozoa in the testicles, vasa deferentia, and vesiculæ.	. . Godard: Ibid., p. 127.
8	42	. . Strangulated hernia.	. . Both in inguinal canals.	. . Healthy.	. . No spermatozoa in the testicles.	. . Debrou: Jour. Hebd. de Médecine et de Chir., tome viii. p. 3.

microscopically, no scientific value can be attached to these observations. It would be objected that the cause of sterility might *possibly* have been in the female.

The facts which have been adduced, as opposed to the conclusion that cryptorchics are sterile, are chiefly instances in which they are reputed to have procreated children. Mr. Poland relates that a man, aged twenty-nine, once in the Dragoons, was admitted into Guy's Hospital on account of an omental hernia. His testicles had not descended, and there was no scrotum. The penis was well developed, and he had all the other signs of virility. He married when he was twenty, had two children by his first wife, and had been married two years to a second wife.[1] Mr. Cock has mentioned to me the case of a man whose testicles had not descended, and in whom the virile functions were perfect. He had married twice, and had children by each wife. He was a man of dissipated habits, and had served in a public-house. Mr. Durham has communicated to me the particulars of the case of a man with double oblique inguinal hernia, and with both testicles lodged in the inguinal canals. He was a well-grown, healthy labourer, aged thirty-two, and was operated on by Mr. Durham, in Guy's Hospital, in consequence of strangulation of the hernia on the left side. The patient recovered favourably. The left testicle was exposed and handled during the operation. It was smaller than usual. He had a masculine development,[2] was married, and his wife had borne him two children. He stated that since puberty he had experienced strong sexual desires, and had always been competent. No opportunity was afforded for the examination of his seminal fluid, and the man scouted the idea of his testicles being inefficient.

I feel no little hesitation in calling in question the claims to paternity in instances of this kind, but it is remarkable that as yet no case has been found in which a retained testicle has been fully proved to be capable of secreting a fertilizing fluid. The observations collected in this paper seem sufficient to show that as a rule they do not; and although I see no valid reason why there should not be exceptions—and Mr. Durham's case may possibly be one—still, the evidence is wanting to establish the exception in either of the instances of reputed paternity which I have mentioned. Dr. Debrou (d'Orleans) relates the case of Lebert, a man aged forty-two, who died in the Hôtel Dieu, at Orleans, of strangulated inguinal hernia on the right side, after four days' illness. After death both of his testicles were found in the inguinal canals, the scrotum being wanting. The body in other respects was that of a robust, well-formed man. He had been married, and was said to have liked intercourse with his wife, who had borne him a son, then eight years of age. His testicles, which were normal in structure, were carefully examined by Gosselin and Godard separately. They were unable to discover spermatozoa in either of them;[3] Debrou adduces this case as an argument to show that the spermatozoa are not necessary to the fertility of the semen; but as their presence is admitted by the best physiologists to be essential, and as they are

[1] Guy's Hospital Reports, Second Series, vol. i. p. 162.

[2] I visited the man in Guy's Hospital, and can bear testimony to his manly appearance.

[3] Gazette Hebdomadaire de Médecine et de Chirurgie, t. viii. 1861, p. 3.

constantly found in the testicles of robust men, we may fairly conclude that the impregnation of the wife was most probably due to another source than the legitimate one.

It has been suggested that the testicles may secrete spermatozoa at one time and not at another, and that although they were not discovered in the foregoing cases, impregnation may have occurred at a period when the testicles were performing their functions properly. Numerous observations on the spermatic fluid by myself, Dr. Davy, and others, have fully shown that in healthy adults the vesiculæ seminales and vasa deferentia almost invariably contain spermatozoa, whilst there is no evidence whatever to show that the testicles secrete a fluid at one time perfect, and at another time destitute of its essential element. There is no analogy to be found in the periodic intermissions in the sexual functions of the lower animals, since in them, when the secretion of the testicles is suspended, the power to copulate is also in abeyance.

As a malposed testicle does not secrete a fertilizing fluid, we have a strong additional reason for promoting the passage of the gland into the scrotum; and in early life, when the testicle has emerged from the abdomen, much may be done by gentle manipulation to obtain this end.

It has not been ascertained satisfactorily why a retained testicle does not perform its secreting function. One cause, no doubt, is imperfect development; for, as I have already remarked, the malplaced glands are small in size, and frequently have not undergone the change which takes place at the approach of puberty. But in several instances, mentioned by Godard, this must have occurred, for he states that the tubuli could be completely unravelled, which is not the case in an undeveloped gland.[1]

2. *Sterility from Obstructions in the Excretory Ducts of the Testicle.*—In 1853, M. Gosselin made known some curious researches in relation to this subject. He carefully examined the semen in twenty men who had been attacked with double epididymitis after gonorrhœa. In fifteen of these cases which were comparatively recent, a callosity existed in the tail of the epididymis at the time they seemed to be cured. In all, the genital functions appeared fully restored and the sperm normal. The semen was repeatedly examined at intervals of several weeks, but no spermatozoa were detected. M. Gosselin lost sight of all but two cases, and in these the return of spermatozoa in the semen occurred after some months, and coincidently with the complete disappearance of the induration in the epididymis on one side. In the remaining five of the twenty cases the double epididymitis had occurred several years previously. One man, aged forty-

[1] With the view of ascertaining what influence simple position might have on the functions of the testicle, I commenced some experiments on animals. It is well known that in certain rodents the testicles remain in the abdomen until the season of heat, when they descend into the scrotum and secrete semen. My experiments on the adult guinea-pig did not answer, for the domestic animal was always in heat. I attempted to close the abdominal ring of the young animal with sutures, in order to prevent the testicle escaping at all from the abdomen, but the parts were so fragile and delicate, that the sutures soon came out, and the object was not attained. I refer to these experiments, because they indicate a course of inquiry which might still be followed out with advantage.

five, had been attacked twenty years before, but the left callosity no longer existed, and spermatozoa were found in the semen. In another man the disease dated back five years, and had left a considerable induration at the lower part of each epididymis. The general health was good. No spermatozoa could be detected. In the three other cases the disease had occurred ten, six, and four years before. There was hardness on both sides. The testicles were otherwise unaltered. The indications of virility were quite satisfactory, and the semen presented its usual appearance. The individuals had all been married several years, but had no children. The sperm was carefully examined and found destitute of spermatozoa. One of them had had children by a former wife before the attack of double epididymitis.[1] Since the publication of the preceding observations, M. Gosselin has met with two cases of men who, after suffering from bilateral epididymitis during their youth, had retained an induration on each side. They had been married several years and had no children. In both the virile powers were not, apparently, weak, but the sperm was entirely wanting in spermatozoa.[2]

The following cases which have occurred in my practice, show the importance of these inquiries:

Case V.—A stout, well-built man, aged forty-two, a widower, desired to obtain my opinion on the propriety of marriage. In early life he had indulged freely in sexual intercourse, and at the age of twenty-eight contracted a gonorrhœa, which was followed by double orchitis. This did not cause any loss of power, and at the age of thirty, he married a young healthy woman. His wife had no children, and died ten years after the marriage. He then formed an illegitimate connexion with a young woman who had previously borne a child, but his acquaintance with her did not lead to her becoming pregnant. He stated that his sexual powers had declined slightly within the last two years, but he was quite efficient. He had repeatedly experienced uneasiness in the testicles the day after sexual intercourse. The question submitted to me was his ability to procreate children, as he contemplated a second marriage in the event of a decision in the affirmative. I found the right testicle of fair size, the left somewhat small, and both rather flaccid. In the lower part of the epididymis of each testicle there was a firm induration a little tender on pressure. Some discharge emitted in sexual intercourse was brought to me for examination. It was whitish, turbid, and glutinous. There was no trace of spermatozoa or spermatic granules. I gave my opinion that, in the event of marriage his wife would be barren.

Case VI.—In 1860, a strongly-built man, aged forty-four, who had just arrived from a distant colony, consulted me in the following difficulty:—Twelve years ago he married a healthy young woman, who bore him a child, now eleven years of age. Two years after marriage he got a chill after a long fatiguing ride in wet boots. He was seized with pain in the loins and bladder, had turbid urine and an urethral discharge, and was afterwards attacked with double orchitis. He became weak and emaciated, and was laid up five or six weeks. On

[1] Archives Générales, 5e Série, t. 11.

[2] Note to the French translation, by M. Gosselin, of my work on Diseases of the Testis, p. 288.

recovery from this illness he found his sexual powers diminished, but he stated that they were still strong, and he was capable of indulging two or three times a week. His wife, however, had not conceived again. She was dissatisfied, desiring to increase her family, and believed he was at fault. It was arranged between them that he should seek advice in the mother country, and in the event of his returning without the ability to beget children, that they should separate. His testicles were rather small and flaccid. At the lower part of the epididymis of each gland there was a distinct induration, and the swellings were morbidly sensitive. The fluid emitted during erotic dreams was examined on two occasions. It was thin, and entirely wanting in spermatozoa. After experiencing sexual desires he had uneasiness in the testicles. I gave the opinion that he was incapable of procreation; but I also ventured to intimate that, however great might be the desire for children, sterility acquired after marriage was not a sufficient ground to justify a separation, especially as he was able to gratify his wife, though not to make her a mother. He gave me to understand, nevertheless, that the arrangement would be carried out.

CASE VII.—A medical gentleman of my acquaintance, aged forty-five, moderately robust, contracted syphilis twenty-five years ago, and the next year had an attack of acute orchitis on the left side. This was followed by complete atrophy of the testicle, the organ being reduced to about the size of a French bean. He suffered at the same time from epididymitis on the right side. Slight secondary symptoms occurred during nearly ten years, but since then there has been no trace of the disease. He married thirteen years ago. His right testicle is of fair size, but there is decided enlargement and induration of the epididymis. He has never been deficient in virile power, and the emissions have been abundant. His wife has never become pregnant. Between three and four years ago, he had occasion to examine the urine of a patient containing spermatozoa, and for the sake of comparison placed some of his own semen in the microscope. He was surprised to find it entirely destitute of spermatozoa. Since then he has frequently searched for them in the fluid emitted in sexual intercourse, but had never succeeded in finding any.

CASE VIII.—In 1858, a gentleman, thirty-eight years of age, consulted me under the following circumstances:—He stated that, in India ten years before, after excitement from drink and excessive indulgence in sexual intercouse, he was attacked with violent inflammation of the prostate or parts around. He was obliged to embark for England, and was unable to obtain advice on board the ship. An abscess formed and burst in three situations—into the rectum, into the urethra, and in the perinæum. After his return to England, an elastic catheter was retained in his bladder for the cure of the urinary sinuses. This caused inflammation of both testicles. He discontinued the instrument and went to the sea-side, where, after many months, the sinuses closed, but he has since been subject to a mucous discharge in his urine. His health was good, and he was robust and active. Seven years ago he married, but his wife had never become pregnant. His desires were strong and his powers sufficient. In intercourse no distinct emission took place. He had the sensation of ejaculation

with uneasiness at the neck of the bladder, but no discharge followed. His urine had been repeatedly examined after coition, but no spermatozoa had been discovered in it. He had no stricture nor enlargement of the prostate. There was a distinct induration in the lower part of the right epididymis. The testicles were, in other respects, sound and of fair size. The absence of emission led me to conclude that the inflammation and abscess had caused an obstruction in the ejaculatory canals. I recommended a prolonged course of the iodide of potassium, and the application of tincture of iodine to the perinæum, without any sanguine hope of absorption of the supposed source of obstruction after so long an existence. No change ensued. In March, 1863, this gentleman, for the first time, called my attention to a small tumour, about the size of a large pea, in the vas deferens, about an inch and a half above the left testicle, which, it was supposed, might obstruct the passage of semen. Being very anxious to acquire the power to impregnate, he requested me to remove the tumour. Though not anticipating a satisfactory result, I consented to perform this slight operation. April 4th. Sensibility having been annihilated by a freezing mixture, and the vas deferens fixed by a clamp, I cut upon the duct, and avoiding the veins around, opened it just below the tumour, and introducing a fine probe, found the canal completely obstructed by the swelling. It consisted of a cyst containing a soft whitish substance like sebaceous matter. This was removed, and an opening made into the duct both above and below. The small wound in the scrotum was closed with a single suture. Matters went on very well for three days when gout attacked one foot, and was shortly followed by orchitis on the left side, with considerable swelling and thickening of the spermatic cord. Under purgative treatment with colchicum the gout subsided, but the orchitis proved indolent. The patient's general health was a good deal disordered. Suppuration occurred in the spermatic cord, and the part did not heal for three weeks. There has been no restoration of the passage for the semen.

M. Godard has recorded an interesting case (Case V. in Table I.) of a strong, vigorous man who had the left testicle in the groin, and the right one, of full size, in the scrotum. When young he was much addicted to women, and became the father of a child. At the age of twenty-one the testicle in the scrotum was attacked with gonorrhœal orchitis, which became chronic, and left a deposit in the tail of the epididymis. This was followed after five years by stricture in the urethra, and a second attack of orchitis in the right testicle. At the age of thirty-three he married, but his wife never became pregnant. She died at the end of five years, and at the age of thirty-nine he married again, but had no children. The ejaculated sperm was examined by M. Godard and others, but no spermatozoa could be detected in it. This is a case of sterility arising from a double cause—from malposition of one testicle, and obstruction in the excretory duct of the other.

The preceding observations show that epididymitis, especially when double, should not be regarded as a trivial and unimportant affection, and that the treatment of it should be prolonged until the effused matter is absorbed and all induration has disappeared, for if the disease be allowed to pass into and remain in a chronic state, permanent obstruction of the excretory duct is liable to ensue. It has been found that under careful treatment callosities obstructing the canal have disappeared at the end of many months, leaving the course of the semen free. M. Godard has related a case in which he had cured sterility from this cause that had lasted eighteen months.

The passage of the semen from the testicle may be prevented by congenital absence of the vas deferens. M. Gosselin examined the sexual organs removed from a man about twenty years of age. The funicular and inguinal portion of the vas deferens was wanting on the right side. The right testicle was healthy, but the ducts of the epididymis were gorged with yellow fluid which contained a quantity of dead spermatozoa. The testicle, vas deferens and vesiculæ seminales on the left side were normal, and contained abundance of spermatozoa. There were none in the right vesicula. John Hunter, in dissecting a male subject, found the vasa deferentia wanting on both sides. The testicles which were in the scrotum were sound and of good size. There are other instances on record of a double imperfection of this kind, the testicles being sound. In such a case the man would of course be sterile. Many years ago I made experiments on animals which were confirmatory of the observation that the testicles may be properly developed though a physical obstacle to the elimination of their secretion is present from birth; and that so long as these organs exist entire, the individual acquires and preserves all the marks of the male sex.[1]

The excretory duct of the testicle is liable also to be interrupted by tubercular deposits in the epididymis. It is well ascertained that this part is much more frequently the seat of tubercle than the body of the gland, and is often extensively diseased whilst the substance of the testicle remains sound.

Case IX.—A young man, aged twenty-eight, moderately robust, was under my care on account of large tubercular deposits in the epididymis of both testicles. Although the disease had existed seven years, and had softened down and suppurated, there was not the slightest indication of morbid change in the substance of the glands, which were of moderate size. His general health was good, and he had no symptom of tubercular disease elsewhere. He had fair sexual powers, but the emitted fluid was small in quantity and contained no spermatozoa.

This cause of sterility did not escape the searching inquiries of M. Godard. In a letter written to me in November, 1860, he remarks, "J'ai toujours constaté que les individus avec double affection tuberculeuse du testicule entraient en erection, pouvaient avoir des rapports sexuels, mais éjaculaient au plus une à deux gouttes de semence absolutement privée de spermatozoïds."

The capacity for sexual intercourse may exist, though in diminished force, in extensive chronic disease of both testicles when the secreting structure is almost entirely destroyed, such as in old-standing strumous orchitis. This will not appear remarkable when it is recollected that coition may be performed for a time even after double castration.

Case X.—A gentleman, aged thirty-two, of robust frame, married, and the father of two children, came under my care on account of

[1] Treatise on Diseases of the Testis, first edit., p. 63.

strumous orchitis, producing great enlargement of the right testicle. His left testicle had been excised for a similar affection seven years before. He still continued sexual indulgence. The disease having resisted all remedies, I removed the remaining testicle. On examination I could find no trace of tubular structure, the enlarged organ consisting of a mass of lymph with scrofulous pus in the centre. There were no spermatozoa in the epididymis and vas deferens. He had intercourse with his wife a week only before the operation.

3. *Sterility from Impediments to the Escape of the Seminal Fluid.*—It is well known that a close stricture in the urethra so completely interrupts the passage of the seminal fluid, that in ejaculation it regurgitates into the bladder, where it mixes with the urine. In erection of the penis the urethra becomes narrowed, so that a stricture which offers but a slight obstacle to the flow of urine may under congestion be sufficient to impede the emission of semen. I have grounds for concluding that sterility from chronic stricture in the urethra exists to a greater extent than is commonly supposed, being in some instances little suspected by the patient himself. The semen not having been ejected, dribbles afterwards from the urethra as erection subsides, and so misleads the patient. As this is a condition which is in most cases remediable by the cure of the stricture, it is unnecessary to say more than to call particular attention to it as not an uncommon source of infertility. In describing Case VIII., I have mentioned that the absence of emissions in copulation led me to conclude that inflammation and abscesses near the prostate gland had occasioned obliteration of the ejaculatory canals, so that there was apparently a double cause for sterility, the excretory ducts also being obstructed. But sterility originating in a closure of the ejaculatory canals is a subject which needs further investigation. They must be liable to injury in lithotomy, and sterility might be the result of a bilateral operation.

Accoucheur physicians have informed me that, in seeking for the cause of sterility in their married patients, they have observed an absence of spermatozoa in the fluid removed from the vagina after sexual intercourse, and they have ascertained that the true cause of barrenness has in many instances rested with the husband. It is supposed that in men exhausted by early excesses the testicles do not secrete, the emitted fluid consisting of the secretions of the vesiculæ and prostate. No doubt this is sometimes the case, for in several weak patients I have detected an absence of spermatozoa. In advancing atrophy of the testicles, before the capacity for intercourse is wholly lost, the glands cease to supply the essential element.

Case XI.—A gentleman, aged forty-seven, a married man of robust appearance, consulted me on account of wasting of both testicles, with failure in sexual power. The wasting had been going on gradually for eighteen months. It commenced during a voyage at sea when he was separated from his wife. I found the testicles soft, and reduced to one-fourth their natural size. They were extremely sensitive. He still enjoyed connexion, but at long intervals. On examination of the fluid removed from the urethra shortly after intercourse, I could find no trace of spermatozoa.

But when the desire and capacity for intercourse are strong, I believe that spermatozoa are never absent from the ejaculated fluid, except from causes which I have described in this communication. When the testicles cease to secrete them, there is defective power of copulation, and the absence of spermatozoa is an indication of incompetency for marital duties.

Two important and delicate questions arise out of these inquiries: 1. Whether a man who has the inclination and power to copulate, but who is nevertheless sterile, is justified in contracting marriage—should such a person be condemned to celibacy? 2. Whether this condition is a sufficient ground for divorce?

1. That a man who is unable to fulfil the command "to be fruitful and multiply" is right in disappointing the hopes and perilling the happiness and perhaps health of a woman cannot, I think, be maintained by any casuist, and in some of the foregoing cases I have felt it my duty to give advice in accordance with this opinion.

It cannot be doubted that in women ready for conception frequent sexual excitement without impregnation is very likely to prove injurious to health. Dr. West mentions the occurrence of chronic ovarian irritation and chronic congestion of the womb leading to hypertrophy of the uterine substance and profuse bleeding from its lining membrane in cases where marriage is sterile.[1] It has been supposed that more important diseases of the female sexual organs, of a chronic character, have owed their origin to irregular and unfruitful excitement. In Case VII., the sterile patient, a medical gentleman, informed me that after six months of married life his wife suffered from some of those obscure symptoms of irritable cervix uteri called chronic inflammation, and he believes that his wife's troubles were caused by non-impregnation. I know also that the wife of another patient whose case is described in this paper, a fine healthy woman before marriage, has since been constantly under the care of accoucheur physicians.

2. The second question is one upon which a surgeon is scarcely called upon to pronounce an opinion. But I may venture to remark, that as sterility in women is not considered an adequate cause for divorce, so the man ought not to pay such a penalty for unsuspected unfruitfulness.

[1] Diseases of Women, Part I., p. 55. Dr. Priestley remarks:—"It is highly probable that sexual excitement which is not followed by the occurrence of pregnancy leads in many cases to permanent congestion of the ovaries, and this may readily be lighted up into more active disease." (Clinical Lecture on Menorrhagia, Medical Times and Gazette, vol. i., 1863, p. 445.)

THE END.

A Contribution to the Normal and Pathological Histology of the Kidneys. By V. RASMUSSEN, Candidate in Medicine and Surgery. Translated from the *Bibliothek for Læger* for April, 1862. By WILLIAM DANIEL MOORE, M.D., T.C.D., M.R.I.A., Honorary Member of the Swedish Society of Physicians, of the Norwegian Medical Society, and of the Royal Medical Society of Copenhagen.

ALTHOUGH it cannot be asserted that cellular pathology is the only true and absolutely valid doctrine, inasmuch as it cannot be denied that, carried out to its ultimate result, it too much loses sight of generalization, and does not knit together all details into a higher organic unity, yet it may be said that it is the culmination of our present knowledge. Even the Vienna School, which, with its postulates and arbitrary interpretations has so long ruled science, has been obliged to bend before the numerous incontrovertible facts, supported on an exact genetic observation—for precisely this is the main strength of the new doctrine—and has quite recently begun to forsake the beaten path of authority and tradition, to turn more to the objective matter-of-fact method. Cellular pathology teaches us to separate the several tissues which compose the organs, and, in morbid processes, to investigate which tissue is the affected one, in order subsequently to estimate and name the disease; hence it is clear that a knowledge of these tissues, and of the elements composing them, as well as of the mode in which they are arranged to form the several organs, is a necessary condition for the comprehension of their pathological changes. As it is, therefore, my object in these pages to give a sketch of the histological relations in certain renal diseases, it will probably be found advisable, first, to direct attention to the normal anatomical conditions, especially to such as are important to us in the appreciation of morbid processes in these organs.

The Renal Vessels.—The striking difference found in the latter stages of the so-called Bright's disease, between the perfectly anemic cortical substance and the strongly hyperemic pyramids, led Virchow to institute some investigations respecting the vascular distribution in the kidneys, as this frequent and almost constant pathological condition was manifestly opposed to the doctrine first promulgated by Bowman, and subsequently adopted by Kölliker. As is well known, this was to the effect that all the blood, brought through the renal artery to the kidneys, with the exception of that circulating in some inconsiderable branches to the investing connective tissue, does not reach the veins without having passed the Malpighian bodies. That the latter are supported everywhere upon the extreme ramifications of the renal artery (vasa afferentia), and from them emerge the efferent vessels, which are differently disposed of. That while, namely, by far the greater part of them pass, after a short course, into an ample capillary net-work encircling the convoluted tubes, those springing from the glomeruli lying nearest to the pyramids pass over into the so-called arteriolæ rectæ. That the latter, which are of considerably greater calibre than the other efferent vessels, enter into the pyramids, and run between the straight canals, dividing, at acute angles, into smaller branches, running, however, in the same direction—which finally, towards the apex of the pyramids, pass into an extended capillary net-work; during this course they, at the same time, give off branches inwards, which form a net around the straight canals, anastomosing with capillaries of the cortical substance.

In opposition to this theory, Arnold, Hyrtl, and Leydig assume that the arteriolæ rectæ spring directly from the main branches of the renal artery. Virchow's views (*Archiv für Pathol. Anat. und Phys.*, Bd. 12) combine both these opposite propositions; inasmuch as, according to him, the arteriolæ rectæ are formed—1, of branches issuing directly from the renal artery (main trunks—arcus vasculosi); 2, of vasa efferentia of the glomeruli situated next to the base of the pyramids; and lastly—3, of capillary outrunners from the cortical net-work. According to Virchow there is, at the boundary between the cortical substance and the pyramids, a neutral space, where the arteriolæ rectæ still form glomeruli, while the vasa efferentia send out lengthened off-shoots, which in general pass over into the capillary net-work of the pyramids, but sometimes both to it and to that of the cortical substance; and as the latter afferent vessels, proceeding from the arteriolæ rectæ, are most frequently very short, it may seem as if the arteriola recta itself, which, in reality, only runs past the glomerulus, were the efferent vessel. As to the distribution of the large vessels, the larger branches of the renal artery appear, through the columnæ Bertini, constantly giving off branches, which most frequently are regularly dichotomous, and which in flat arches (arcus seu fornices vasculosi) shoot through the outer part of the base of the pyramids, and thence obliquely up through the neutral zone, in order, finally, about the middle of the pyramids, to meet—though without anastomosing—with a corresponding branch from the opposite side, and to ascend in the cortical substance. These arcus vasculosi are to be considered as trunks, which now again give off branches, whereof by far the greatest part proceed from the convexity, and ascend directly or obliquely in the cortical substance between its several lobes. These branches, the so-called interlobular arteries, give off afferent vessels, which, as Virchow first demonstrated, do not arise at an acute angle, but in general form more or less backward curved arches; that is, in irritation of the papillæ, a circumstance which we shall subsequently see is of essential import. From this view it therefore follows that the cortical substance and the pyramids have a circulation independent of each other; the pathological state just mentioned, which, according to an older theory respecting the vascular distribution in the kidneys, was inexplicable, has now found its natural simple explanation: if the blood, from any cause, becomes obstructed in its free entrance into the cortical substance, a compensatory congestion of, or determination to, the pyramids takes place, and *vice versâ*.

The veins, of course, pass, for the most part, into the renal veins, but the peripheric veins are at the same time connected with the renal capsule, and through it with the venæ azygos and hemi-azygos, a circumstance which is easily demonstrated by drawing away the capsule in cases of venous hyperemia; the connexion takes place through the stellulæ Verheynii, which in such cases are distinctly apparent; and, on more accurate examination, the torn branch is easily found.

Renal Parenchyma.—The whitish striæ in the pyramids, which give the latter the characteristic feathery appearance, correspond to ramifications of a single urinary canal opening upon the papilla. These, the so-called Ferrein's pyramids—properly speaking this name does not belong to them, but in modern nomenclature they are most frequently so termed—everywhere tend, and also in the columnæ Bertini, towards the cortical substance; but in entering the latter the several canals, hitherto running parallel to one another, curve in a centripetal direction towards the sides, and make, in irregular windings, for a glomerulus; meantime the original pyramid becomes more and more slender; and, after having passed through about two-thirds of the cortical substance, it ceases, and thenceforward to the surface of the kidney only tortuous canals are found. In this mode, therefore, conical figures of straight canals also are formed, with the base towards the great pyramids; and it is, properly speaking, to them that the name Ferrein's pyramids applies. Such a pyramid, with its series of tortuous canals, constitutes a renal lobule. A section, carried perpendicularly to the axis of the latter, will therefore present very different appearances in the several points: towards the surface of the kidneys purely tortuous canals; internally, towards the pyramids, predominatingly straight ones; and transitions between these two. When we have, in the usual manner, by a section parallel to the axis, obtained a smooth section of the kidney, we often see these lobuli bounded by reddish striæ (vasa interlobularia); however, these vessels do not form actual boundaries, they are only like isolated partitions, met with at a distance from one another; but, where these are wanting, the lobules, and therefore the tortuous canals, are in immediate contact with one another. The case is here the same as with the acini of the liver, with which, on the whole, the lobules of the kidney may be compared, for there, too, the net-works of hepatic cells are separated from one another only by the vessels and the connective tissue accompanying them.

This is, so to speak, the coarser anatomy of the kidneys, so far as it goes, which, on more accurate investigation, is easily observed in the smooth section. In addition it may be stated, that on both sides of the interlobular arteries glomeruli are seen as small clear points, arranged in series. The renal parenchyma must, in order to be called healthy, not allow the individual urinary canal to appear too prominently, and it must be half transparent. Kidneys presenting such perfectly healthy parenchyma are very rarely seen on section, when death has not occurred suddenly, or, at all events, after a very short illness; most frequently there is a change, though only a slight one, of the epithelium in the renal canals, especially the tortuous ones, which gives them a dull whitish-grey appearance, and makes their outline appear more marked.

As to the more minute examination of the urinary canals and glomeruli, their membrana propria is in general said to be structureless; and this is in fact the case, although Beer (*die Bindesubstants der menschl. Niere*, Berlin, 1859) says he has demonstrated minute ramified corpuscles of connective tissue in them; here and there nuclei are found enclosed in the doubly contoured membrane. The tunicæ propriæ, freed from the epithelium, have a tendency to form fine folds, especially in a longitudinal direction, a circumstance to which Kölliker has already called attention; and this it is which has led Beer to assume the existence of corpuscles of connective tissue in them, the more so as the carmine, used in the investigation, readily adheres to such points, and thus makes the appearance still more deceptive. The epithelium on the inside consists of polygonal cells, with a large round, sharply contoured, granular nucleus, which, especially in children, is remarkably large, almost completely filling up the cell; rarely do we observe cells with two nuclei indicating a division. That the cells are polygonal, and in general have no outlets, can be proved by treating them with a weak solution of nitrate of silver and solution of salt, a method which has recently been employed by v. Recklinghausen, and whereby he has shown, that in all kinds of epithelium, there is a connective tissue between the individual cells, which is coloured black by the precipitated chloride of silver. By this mode of treatment the epithelium at present under our consideration exhibits acute, black, polygonal boundary lines; where it has been supposed that ramified epithelial cells have been met with in healthy kidneys, this appearance may possibly depend upon the fact, that portions of the connective substance have remained adherent, as fine filamen ts,to isolated cells. Such isolated cells, furnished with outlets, were seen by Beckmann in slight forms of nephritis. This connective substance is tolerably strongly developed in the renal epithelium, on which account the cells adhere firmly to one another, and, indeed, often separate in complete tubes from the membrane. The contents of the cells are finely granular, and are readily clarified by acetic acid; the enveloping membrane is exceedingly fine and slender. Wittich has, it is true (*Virchow's Archiv*, Bd. 10), endeavoured to deny the existence of the

membrane, considering these epithelial cells, which he connects externally with the urine, and internally with the blood-vessels, as nuclei surrounded with a highly albuminous protoplasm. Although the membrane can no longer be considered as essential to the formation of a cell, it is easy to prove that a distinct membrane is here present. Thus, if we treat the cells with water, they will endosmotically take up the latter, and become distended; but it is at the same time evident that a limiting membrane exercises a resistance against this distension, and, when the intercellular pressure becomes too strong, breaks. This endosmotic action makes it necessary, in examining the urinary canals, to use a solution of sugar, or some such concentrated fluid, instead of water.

This precaution is the more important, as precisely the largeness of the cells, and the consequently diminished calibre of the urinary canals are often the first indication of nutritive disturbance. On the other hand we may, by means of water, separate whole portions of urinary canals from epithelial cylinders; in the latter, namely, the cells will not be hindered from becoming distended outwards, and from so, instead of the smooth cylinder, producing an uneven one. In general, with the exception of those next the papillæ, the straight canals are of less calibre than the convoluted ones, but still their cavity is comparatively larger; this depends on the fact that the epithelial cells are flatter, while those in the convoluted canals are both larger in circumference, and also project more, protruding into the cavity of the canal. These last have, to a certain extent, more similarity to the epithelium of the glands; the first, to that of the excretory ducts of the latter.

The glomeruli are surrounded with a membrane with longitudinal nuclei, resembling the tunica propria of the urinary canals. The epithelium on the inside is not always easily perceptible; it has been supposed that it was continued over on the vascular loops themselves, but this is scarcely correct. The capsule has a tendency to separate; sometimes it is seen still adherent to the glomerulus, sometimes it is quite free, especially towards the edge of the section. Under the microscope the glomeruli, in general, present themselves in a rosette form, inasmuch as we do not see the whole course of the capillary loops, but only their convexity; out towards the edge, especially where the capsule is absent, the bulgings of the individual capillaries are seen, often containing small shining bodies (blood cells). Such bulgings may resemble cells; they call to mind the depressions on the capillaries in the pulmonary cavities, which also have been taken for epithelium. On the addition of acetic acid numerous nuclei appear, which for the most part belong to the capillaries; if the observer has been so fortunate, which is, however, very rarely the case, at the same time to get the vasa afferentia and efferentia, he will see their transverse nuclei. According to Beckmann's investigations (*Virchow's Archiv*, Bd. 20), which agree with Key's, the proper glomerulus, and, therefore, the vascular loops, are, at least in children, not constantly in adults, surrounded by a slight membrane of connective tissue, studded with stellated or fusiform cells, which in part lie immediately on the surface, and partly press in between the several vascular loops.

The Interstitial Connective Tissue.—This is of great importance in pathological anatomy; in the ordinary manuals of histology but little attention is given to it, or the nature of the tissue is misunderstood. If we examine a thin section of the kidney under the microscope, the epithelium having been previously, so far as possible, brushed off, we shall see the several openings of the urinary canals bounded by a slight transparent line (the tunica propria). It is evident that the transverse section of the convoluted canals will present all kinds of different forms, but the straight canals also will be met with under very various circumstances, at one time more perpendicular, at another more parallel to their axes. Now, as even the thinnest section always has a certain relative thickness, and every divided canal has a superior and an inferior opening, which, most frequently, do not cover one another, a careful application of the microscope is necessary to avoid false conclusions. To illustrate this more precisely, let us for a moment suppose a urinary canal ascending obliquely into a section, to the lower opening of which canal the microscope is applied. If we now compare this with the nearest adjoining urinary canal, whose upper opening alone we possibly see, or at least use a sa means of comparison, the distance between the two canals will seem considerably greater than it really is, since the wall of the obliquely ascending canal will be taken as a distance, as the eye must assume that the two openings lie in the same plain. The image becomes still more deceptive from the fact that the nuclei of the capillaries, encircling the urinary canals, appear through the thin wall, and are mistaken for nuclei belonging to the connective tissue. If, on the contrary, we raise the tube of the microscope a little we shall see the two openings approach more and more, and the actual distance first becomes apparent when the superior opening of the oblique canal lies accurately in the focus. Simple as this circumstance is, and easy as it is to demonstrate it in a diagram, it is equally easy to overlook it in practice. The distance between the several urinary canals is, in fact, very small. If we examine the drawing in *Kölliker's Gewebelehre*, (Third Edition, p. 205,) it is almost certain that the great distances to be found in most places between the urinary canals depend on such an inclusion of the wall; and when it is in the same place also stated, that the nuclei lying between the canals all belong to connective tissue, this must depend only on an accidental inaccuracy. It is, on the whole, a fault, that almost all drawings in the histological manuals are more or less diagrammatic; they ought to be either purely so, or perfectly true to nature; anything intermediate is only confusing.

If a person commences his microscopic studies by seeking for the corresponding images in nature he will soon lose all pleasure and courage in his labour if he does not know how to estimate the meaning of such a drawing. The proper interstitial connective tissue has been first definitively demonstrated by Beer. It is found both in the cortical substance and in the pyramids, but in greatest quantity in the first named. It consists of a hyaline intercellular substance, lying around the urinary canals, between these and the capillaries, with interspersed stellated and fusiform elements. It is more abundant in children than in adults. These investigations of Beer have recently been confirmed by Smidt (de Renum Structurâ Questiones, Göttingen, 1861—*Henle und Pfeufer's Zeitschrift*). This interstitial tissue stands in the vessels in connexion with the external thin layer of connective tissue already described by Kölliker, which gives the kidney its smooth surface, by filling up the inequalities which the highly convoluted and bulging urinary canals would otherwise form. In order clearly to demonstrate this interstitial connective tissue it is necessary to inject the kidneys, and to brush away the epithelium; by this the nuclei in the capillaries, which are inseparable from the connective tissue, are removed; finally, if the preparation be treated with carmine, the elements of connective tissue will become more distinct. In employing carmine, weak solutions must be used—a couple of drops of an almost saturated solution of carmine in ammonia to the ounce of water. It is best previously to moisten the preparation with a little spirit of wine or dilute chromic acid, whereby the albumen is precipitated and the colouring is promoted; the nuclei are coloured, afterwards the entire cells, and for this several hours are required.

Of the Pathological Changes in the Kidneys, which are referable to the term Morbus Brightii.

In studying renal diseases, the object of our investigation is to establish the three following principal points:—1. What tissue or tissues are affected (vessels, parenchyma, or interstitial connective tissue); 2, whether only the cortical substance or the pyramids are attacked, or both together; and lastly, 3, whether the affection is partial or diffused. In the commencement a definite tissue can always be indicated as the starting point of the affection; later this is most frequently not possible; the several tissues are dependent on each other, so that they are often consecutively attacked; but, on the other hand, the several lobuli possess also independence of each other, and we have already seen that the vascular system of the cortical substance and that of the pyramids are to a certain extent independent of one another. It is especially chronic affections of the kidney which will be the subject of our consideration in an anatomico-pathological point of view. Formerly these were comprised under the name of *Morbus Brightii*, but this is a very inaccurate denomination, and one which conveys but little information. The older investigators properly included under this term only what we now call parenchymatous nephritis, whose terminal stage is the characteristic and striking granular atrophy. Although this form is by far the most frequent, modern researches have revealed other pathological changes in the kidneys, which clinical physicians have not yet succeeded in definitely diagnosing from the parenchymatous nephritis; and it becomes, therefore, necessary to refer these also to the designation *Morbus Brightii*, so far as such a name shall be retained as a common denomination for these extremely different conditions. The essential symptoms are the albuminuria and the diminished secretion of urine, while the so-called fibrin cylinders have not the signification which Frerichs ascribes to them; they occur, at all events, only in the parenchymatous nephritis, and not even constantly in that. Here are three essentially different affections to be considered, each occupying its own tissue:—1. The amyloid degeneration of the kidney; 2, the parenchymatous; and 3, the interstitial nephritis. They may complicate one another; nay, all three may be present at once; sometimes one, sometimes another occurs first, but the parenchymatous is most frequently the primary affection.

The Amyloid Degeneration of the Kidney.—Unlike the liver, and especially the spleen, where the amyloid degeneration most frequently can, with perfect certainty, be established microscopically, and without having recourse to the reaction, the amyloid kidney is, in the rarest possible cases and that only in the highest degrees of degeneration, to be recognised in that way, and never with absolute certainty. The reason of this is, that in the first named organs, the proper parenchyma is chiefly affected, in the liver the hepatic cells, in the spleen either the follicles (sago-spleen) or the pulp (waxy-spleen), while the affection has a much greater extent than in the kidneys, where as a rule it is limited to the vessels, and does not spread to the proper parenchyma. It is, therefore, difficult to give definite non-microscopical anatomical diagnostic signs, particularly as the disease scarcely ever occurs alone, but is most frequently combined with a parenchymatous or interstitial nephritis, or, what is not unusual, with a result of this last, the interstitial fatty kidney. This latter combination is not unfrequently met with in individuals who have succumbed in the later stages of syphilis; but in what relation the two affections stand to each other is difficult to decide; probably they are collateral, dependent on the same etiological element, as they do not necessarily go together; for under similar circumstances, we at one time meet amyloid, at another interstitial fatty kidney. It is true it is not syphilis as such, but the dyscrasia which it, or the mercury, that is most frequently employed, produces, which is the cause; consequently it acts upon the kidneys in the same mode as chronic wasting diseases, especially chronic affections of the bones, tuberculosis,

&c. In the vast majority of cases the affection is met with in a great number of other organs, particularly the liver, the spleen, and the intestinal canal, and so produces death. As to the characters assigned to the amyloid kidney, much importance is not to be attributed to them. The Vienna School has indicated a solid consistence as something essential; but this is often not met with; also the lardaceous or waxy appearance—hence the name lardaceous or waxy kidney—but precisely in the kidney which exhibits such an appearance, we will often in vain seek amyloid, while it may be found in others which have only the appearance of being the seat of parenchymatous or interstitial changes. Yet it cannot be denied that in extreme degrees of degeneration we may even, with the microscope, acquire a suspicion, approximating to certainty, of the presence of amyloid. We then see the glomeruli stand sharply out as enlarged, shining, prominent bodies of a whitish-grey colour; the same appearance is presented by the vasa afferentia and other arteries accidentally lying in the surface of section. But the only certain and decisive sign is the reaction, which ought never to be omitted, when we have the least suspicion of the presence of amyloid. If we pour a small quantity of tincture of iodine on such a kidney, and rub it with the finger over the surface, we will see the glomeruli and the vessels assume a wine-red characteristic colour. The seat of the degeneration is the vessels alone, and the question is then, what vessels are attacked, in what order, and in what manner. It is chiefly the small vessels; first and foremost the glomeruli and vasa afferentia, next the vasa efferentia and the capillaries in the cortical substance, and finally, the arteriolæ rectæ are also attacked; it is rarely that the large vessels in the cortical substance and the main trunks of the arteriolæ rectæ degenerate. It is very long before any other tissue is attacked, and most frequently this does not occur; only in very rare cases does the affection extend to the tunicæ propriæ. The change consists in the deposition of a substance in the walls of the vessels, rendering them thickened, rigid, shining, and diminishing their calibre. This substance, the amyloid, penetrates the several elements, destroys their structure, so that the characteristic texture is changed, the whole becomes, in fact, a structureless, homogeneous mass. The glomeruli become pale, void of blood, shining, and this almost asbestos-like lustre is extremely characteristic; frequently in the very slightest degrees of the affection a single such shining loop of vessels is seen. By reason of the change in the glomeruli, and the thence resulting diminished supply of blood, the cortical substance also becomes anemic, while the hyperemia increases in the pyramids. Hemorrhages, too, may arise in consequence of the increased pressure on the rigid inelastic vascular walls, and we therefore not unfrequently find reddish or brownish streaks and spots, corresponding to the blood extravasated within or externally to the urinary canals. The colour is of different shades, according as the blood is fresher or has undergone changes, especially in its pigment. The amyloid degeneration is always bilateral.

There is, however, another kind of change in the renal vessels, which is not due to amyloid degeneration, but which, in the same manner thickens the walls, and makes them less permeable, and therefore deserves to be mentioned here. It is a change corresponding to the so-called end-arteritis such as is so frequently met with in the larger vessels. We here also find two different results: arteriosclerosis, produced by the organization of the newly formed elements, and atheromatous degeneration by a fusion of the latter in fatty degeneration. The first is met with particularly in the larger vessels, but it may extend even to the glomeruli; the second is most frequent in the glomeruli and the smaller vessels. This change in the renal vessels does not always coincide with a similar affection of the larger vessels, especially the aorta, but it does so in the great majority of cases. It is only the proper fatty degeneration we shall consider more particularly in its different stages. In the commencement, an increase of the nuclei of the capillaries is seen; these divide, move farther from one another, and thereby elongate the several loops in the glomeruli without at the same time increasing their calibre; as the exciting cause of such a hyperplasia, cellular pathology has, as is well known, assumed an irritation; of what nature this is cannot be definitely stated, probably it proceeds from the blood. At this stage the process may be stationary. If, however, it advances farther, small, finely-divided fatty particles begin to show themselves around the nuclei, and this always indicates a destructive character; these fatty granules increase, the nuclei disappear, and in their place we find an aggregate of fatty molecules. Thus a whole glomerulus may degenerate; and this must, of course, produce the same effect as the amyloid degeneration—diminished permeability and transudation, with a tendency to rupture of the walls. Dissecting aneurism, such as we so frequently see in similar changes in the cerebral arteries, is here much rarer. Such a fatty degeneration of the glomeruli may acquire a microscopic similarity to amyloid, the glomeruli becoming enlarged and of a greyish white colour. The reaction and microscopic examination together will remove every doubt. Instead of the smooth, shining glomeruli are seen, by transmitted light, dark, irregularly formed, scattered or continuous fatty masses lying in the course of the vascular loops.

A few words more about the reaction so often spoken of; for its correct employment is of the greatest importance in answering the question whether amyloid is present or not. In many cases the affection is mistaken, because the test is inadequately applied, and for the same reason—for the observer is unwilling to throw the blame on himself—it has been attempted to deny to the reaction the importance it really possesses. With iodine the amyloid parts are coloured of a beautiful

wine-red, with a slightly violet tint; the colour has some resemblance to that of blood; and such an artery treated with iodine may appear as if it were filled with blood. We, in general, use iodine, dissolved in iodide of potassium—tincture of iodine evaporates too rapidly—but a dilute solution, often presenting only a slightly brownish colour, is sufficient; if the solution is too strong it attacks the whole tissue, rendering it strongly brownish and opaque; with weak solutions we are able to act almost exclusively on the amyloid parts; and the strongly wine-red colour then comes out exceedingly well marked, in contrast to the light iodine colour of the rest of the tissue. One or more drops of the solution of iodine should be applied to the preparation, over which a needle or delicate scalpel is to be passed, so as to cause the iodine to penetrate better. As is well known the iodine evaporates rapidly, it must therefore be repeatedly renewed, that already applied being removed with a dry brush or bibulous paper. When the iodine and sulphuric acid reaction has succeeded well it should not give any pure blue, or, least of all, a bluish-black colour—for then the sulphuric acid has had a destructive action on the tissue—but a beautiful violet, somewhat tending to a bluish colour. A successful preparation presents a very beautiful appearance of the structure of the kidney; we may succeed in seeing a larger or smaller portion of an interlobular artery with its afferent vessels, and the glomeruli appended to these of a splendid violet colour, so that we might suppose we had injected the kidney itself. Unfortunately the colour is more beautiful than durable; even if we take ever so much trouble to preserve it and carefully cement the preparation, in the course of a few days the colour will have disappeared in consequence of the evaporation of the iodine. The following is the process:—The preparation, which has been treated with iodine in the manner detailed above, is freed from the superfluous fluid and covered with a glass; to the edge of this a very small drop of concentrated sulphuric acid is applied, and the preparation is laid aside for some hours, or a whole day. These are the original directions given by Virchow, and to which he still adheres. However, we rarely obtain, in this mode, very beautiful preparations; in some places the acid has acted too strongly, in others too feebly. With some practice and a little dexterity we can, by gently passing a glass rod, moistened with sulphuric acid, over the preparation, without actually touching it, quickly produce very beautiful results. The chief difficulty is to get the sulphuric acid to act in a concentrated form, and in the smallest possible quantity. Still it must be observed that the preparation ought to be examined while fresh; if it be one or two days old a beautiful colour is never obtained—it becomes of a dirty greenish; on the other hand the reaction succeeds well in preparations which have been preserved in spirit or chromic acid.

The Parenchymatous Nephritis.

Although the relation of the epithelium of the renal canals to the urinary secretion has not been satisfactorily explained, it is nevertheless certain that it plays a part; still the importance of the epithelial cells for the secretion is not uniformly great, which is due to the different structure they exhibit in different places. It has already been mentioned, in speaking of the anatomy of the urinary canals, that the epithelial cells in the convoluted canals, especially in those which lie next to the glomeruli, and therefore first come in contact with the secreted urine, are larger and richer in albuminates, and correspond most closely to the epithelium of glands, while those in the straight canals are flatter and poorer in contents, and resemble the epithelium in the excretory ducts of glands. Under pathological conditions, too, there is a difference in the importance of the epithelium; a disease which attacks the first-mentioned epithelial cells, and renders them inactive, produces a change in the urinary secretion, and thereby acts injuriously on the economy of the whole body, and becomes dangerous to life; if, on the contrary, the process is confined exclusively to the epithelium of the straight canals, only abnormal constituents are mixed with the urine, the secretion itself is not interfered with, and such an affection is consequently of much less importance. We have, therefore, under the parenchymatous nephritis, in the more extended sense of the term, two different processes to consider: the papillary catarrh, which attacks the epithelium in the straight canals, and the proper parenchymatous nephritis, which attacks the proper parenchyma, or that which is of importance to the secretion.

The Papillary Catarrh, or catarrhal nephritis, is tolerably frequent, although not so frequent as the bronchial catarrh, with which it may be compared. It is often continued from the bladder, or even from the urethra, though it may also derive its cause from within, as after the use of cantharides and acid diuretics. It is frequently complicated with parenchymatous nephritis; and possibly the affection, slight in itself, is then the starting point of the more important parenchymatous process, in the same manner as an ordinary bronchial catarrh, when long continued, may become the source of more serious affections, as tuberculous peribronchitis and broncho-pneumonia. In hard drinkers, in whom this combination of papillary catarrh and parenchymatous nephritis is often met with, this is perhaps the case, for alcoholic drinks also may, by continued use, give rise to chronic papillary catarrhs; yet, in these, the parenchymatous nephritis may also depend on the general disturbance of nutrition, from which such persons suffer. The seat of the affection is, as has been observed, the straight canals, and especially the papillæ. Here a whitish or slightly yellowish, somewhat shining striation is seen, corresponding to the course of the urinary canals; and, by the side of this, hyperemia is observed in the intervening vessels. On pressure, a more or less abundant quantity of a milky or creamy fluid

flows from the openings in the papillæ. In those cases where the disease is produced by cantharides or such like acrid matters, great hyperemia and ecchymosed spots are observed over the whole kidney, both on the surface and in the parenchyma itself. If the disease lasts longer, the distended urinary canals exercise a pressure on the vessels, the hyperemia diminishes more and more, and at last is seen only as a wreath set around the base of the pyramids. As to the peculiar nature of the disease, it is certain that in many cases it is limited to a production of cells and exudation of the latter, mixed with mucous catarrhal products; in these cases, Johnson's name of desquamative nephritis is very suitable; but the process cannot be compared to the desquamation of the epidermis, as in scarlatina, for this is the termination, the former the commencement of the affection. But it is, on the other hand, also indubitable, that a process similar to that which takes place in the proper parenchymatous nephritis may exist, with fatty metamorphosis and destruction of the whole epithelium. This occurs especially in the more acute, and, if we will, more degenerated cases, such as is not uncommonly observed in cholera, ichorous infectious diseases, and severe croupy pneumonia. Microscopic investigation will afford different results in consequence hereof. In the first case we shall find the dilated and bulging canals filled with a quantity of cells, with all the signs of an abundant production; in some we see a round, in others a more extended nucleus, as if on the point of dividing, and in others again we observe two or three nuclei. In two cases of papillary catarrh in children I saw at the same time ramified cells—the only case in which I have met with such; some of them closely resembled multipolar ganglionic cells, and the contents extended into the offshoots; others were more fusiform or club-shaped, running out into a long, delicate thread. Where several such cells lay together it gave the idea as if these different forms had arisen from lateral pressure caused by the abundant production of cells. The cells in the continued parts are in general very small, yet they never acquire the characteristic form and appearance of proper pus cells; in some pigment is seen, in others small fatty granules, just as in other catarrhs. Mucous products are deposited in the urinary canals also as soft, cylindrical, often plaited masses, with burst cells; they are incorrectly referred to the so-called fibrin cylinders. In the second case the urinary canals will also be distended, bulging, but filled with a detritus-like mass, formed of the wholly or only partially destroyed epithelial cells.

The Proper Parenchymatous Nephritis.—It was the so-called Bright's Disease which first led Virchow to propound his celebrated theory respecting parenchymatous inflammations. He showed that the disease is essentially connected with the epithelium, that it may be limited to the same, so that no free fibrinous exudation is deposited in the urinary canals; but that, on the contrary, the elements themselves are in a condition to produce what was formerly mistaken for metamorphoses of a free exudation (inflammatory globules, fibrin-cylinders). He introduced the name parenchymatous nephritis. The disease, in general, attacks both kidneys. It is in this case the epithelium of the convoluted canals, therefore the proper parenchyma, which is affected. The changes the individual cells undergo are the same as in all parenchymatous inflammations. The cells begin by taking up a large quantity of solid nourishing materials (albuminates), whereby they become distended, larger (hypertrophied); by reason of the abundant, dense, finely granular protoplasm they become turbid, so that the nuclei are concealed; it becomes difficult to recognise the boundary of the several cells; they coalesce, or, as it were, adhere together; on the addition of dilute acetic acid, however, the nuclei again distinctly appear, and also, frequently, the membranes. In the next place small, fine, distinct, fatty granules begin to appear in the contents of the cells, and first around the nuclei; these increase more and more, while, at the same time, the nuclei disappear; the cells are at length completely filled with fatty granules, and finally vanish; the membrane, too, and the granular fatty mass become free (inflammatory globules). Easy as it is to follow the change in the individual cells, the changes thereby caused in the whole kidney become difficult to comprehend and to describe, and for this reason: that the process does not run a uniform course throughout the whole kidney; all the stages which the several cells pass through are often found united in one and the same kidney; finally, at a later stage of the disease, an interstitial nephritis most frequently supervenes. It is on account of these difficulties that a number of stages have been described, without rendering the state of things plainer or easier to understand. I shall describe only three stages, which are, of course, connected by intervening ones. The first stage cannot be anatomically distinguished from the condition which occurs in many acute diseases (typhus fever, scarlatina), and in many chronic affections, especially of the heart and lungs, or, in general, in all diseases with disturbances of nutrition. In infectious diseases (puerperal affections, glanders, &c.) there is found, simultaneously with parenchymatous inflammation in other organs, especially the liver, a similar condition of the kidneys. In the slighter degrees it occurs, therefore, so to speak, as a rule on dissection, and therefore it is exceedingly difficult to obtain perfectly healthy human kidneys for examination. This stage may be compared to the so-called stage of obstruction in croupy pneumonia. The kidney is swollen, œdematous, the capsule is easily torn off; on the smooth surface, which is less bright and shining than usual, there most frequently appears an elegant design of polygonal, or approximatively round figures, produced by the loaded interlobular vessels, which here and there form knotty points, as precursors of the subsequent stellated form. On cutting through the kidney, or on pressure, a bloody, serous fluid can be expressed.

On the surface of section hyperemia is observed in all vessels, sometimes also small extravasations of blood, in general in the urinary canals. The anatomical structure of the several lobules can often be observed in such kidneys much more distinctly than in perfectly healthy ones. The lobules are, that is to say, well marked out by the congested interlobular arteries, and these bear, on both sides, in rows, the red, point-like, striking glomeruli. The contours of the urinary canals appear well marked, especially those of the external convoluted ones, and of a whitish-grey colour. When the urinary canals present such an appearance it may even macroscopically be asserted that a change of the epithelium exists, for the tunicæ propriæ are too delicate and thin to admit of their being seen, under any circumstances, with the naked eye. The microscope confirms this assumption. The epithelial cells are seen enlarged, slightly opaque, projecting more than usual into the cavity of the canals; the glomeruli are congested, but are otherwise natural.

The second stage will, if the first be compared to the stage of obstruction in croupy pneumonia, correspond to that of red hepatization. The kidney is of normal size, or somewhat enlarged, but flaccid, indicating a change in the elasticity of the connective tissue. The surface is smooth, or presents a slightly velvety unevenness in consequence of the increased volume of the several lobules; the capsule separates easily. On section, the cortical substance appears somewhat broader and anemic, because the interlobular arteries have been emptied by the pressure of the urinary canals becoming more distended; the boundaries between the different lobules are not recognisable, nor is the contour of the several urinary canals; the whole cortical substance is of a dull white uniform lardaceous appearance; the glomeruli are anemic, small, hard to recognise; the form of the pyramids is preserved, their canals are either wholly free or are but slightly obstructed. Papillary catarrh is not unfrequently present. From the base of the pyramids a strongly reddish colour is observed, spreading over the whole pyramid, with the exception of the papilla, which is most frequently pale. This is, as nearly as possible, the Bright's kidney. The unpractised eye may find it difficult to distinguish such a kidney from an anemic but otherwise healthy kidney; but in the latter the surface of section is reflecting, the eye is able as it were to penetrate into its substance; in the former it is dull and opaque. On account of the difficulty of efflux of the venous blood a portion tends to the surface of the kidney, through the stellulæ Verheynii, to the capsule and adipose capsule, which are loaded with dark venous trunks. In the renal vein, too, the blood will flow more slowly, so that thrombi may form, and be continued thence into the vena cava—nay, completely up to the heart; detached particles may form infarctions in the lungs; usually, however, such thrombi become organized to form connective tissue, and are thus rendered less dangerous. In this stage an interstitial nephritis often supervenes, and especially when the process runs a more chronic course; if its course is, on the contrary, more acute (acute Bright's Disease), the affection is confined to the epithelium. In puerperal fever the process is often very rapid, with uremic symptoms; likewise, in the parenchymatous nephritis accompanying the so-called yellow atrophy of the liver, to which the typhoid symptoms are referable. Under the microscope the urinary canals appear, in this stage, bulging, distended, occasionally varicose; the cells are hypertrophied, highly obstructed, some fatty granules begin to form; the epithelium of the straight canals is always more or less affected; occasionally the shining fibrin-cylinders are seen in these canals. Retrogression is, therefore, in this stage at least, possible. With it the acute active process terminates, and—

The third stage becomes, properly speaking, only a result of the morbid process—if we will a resolution, a recovery, although with loss of substance. This stage is the complete fatty metamorphosis of the cells—a process which, with respect to many new formations, we call a resolution; the difference lies not in the process itself, but in the different importance of the elements. Perhaps here, also, as well as in the proper resolution, a resorption takes place of the emulsive mass formed by the fusion of the cells; the greatest part is, it is true, removed with the urine; but where the glomeruli are destroyed this is not possible, and yet it is a fact that the urinary canals become empty and collapse.

The kidney may still, in this stage, in rare cases, be large and flaccid; and this indicates a relatively rapid course of the process; but in general it is small, shrunken, and firm to the touch. The capsule is difficult to separate—though this is not always the case; this adherence of the capsule may also be due to a perinephritis, especially to an inflammation of the layer of connective tissue enveloping the kidney; and in such cases portions of the renal parenchyma will usually come off when the capsule is separated. On the surface of the kidney numerous dark and congested venous trunks and stellæ are observed; it is uneven, in the extreme degrees of the affection, with greyish or yellowish elevations, some of them as large as peas; and between these finer granulations are seen, scattered here and there, calcified glomeruli, and not unfrequently small cysts; the substance is hard, almost schirrous to the knife. On section, the cortical substance is found to be greatly diminished, slender, often forming only a shell around the pyramids, and of the same appearance as the granulations. The process has also extended into the pyramids, and it appears, therefore, as if the cortical substance had pushed in and dislodged a portion of them; their base appears truncated, their feathery structure is lost; the glomeruli are small, anemic, and are, most frequently, not recognisable except when they are calcified. Frequently we find in such kidneys cysts, whose connexion with the urinary canals was first demonstrated by Beckmann; they vary from a microscopic minuteness to the size of nuts; they are filled with a gelatinous mass, and invested with an epithelium which is formed by the constriction, or complete cutting off of the urinary canals by the irregular contraction, and which is more and more distended by the accumulated mass of the destroyed cells. In such small microscopic cysts and constrictions fibrin-cylinders are usually found; most frequently in the pyramids, rarely in the convoluted canals. The granulations correspond to the still relatively sound, or rather least affected parts—the depressions between them to the empty collapsed canals; such collapsed places often present a reddish colour, the pressure on the vessels having ceased, and the circulation having thus again become freer. On account of these granulations the granular atrophy has been compared to the so-called cirrhosis of the liver, and has received the name of cirrhosis of the kidney; but it is only an external, superficial resemblance which exists between them, no essential agreement is to be found between the two processes. In the liver it is, as is well known, not the hepatic cells which are primarily attacked, but the inter-acinous connective tissue—while in the kidneys the proper point of issue lies in the parenchyma itself. The parenchymatous process is, in this stage, seldom pure, usually it is complicated with an interstitial nephritis; and on this the appearance of the surface will depend. The latter affection, too, is at length attended with granular atrophy, but in general with greater elevations. If both processes proceed equally and uniformly throughout the whole kidney, a smooth atrophy may be the result. Microscopic examination exhibits most of the canals distended, often two or three times wider than is normally the case—bulging; and this is also true with respect to the straight canals, with here and there the constrictions and cysts already mentioned. The contents are an emulsive mass of detritus, with fragments of cells of various sizes; some canals are seen collapsed and folded, and in others, again, the epithelium is still comparatively well preserved. The glomeruli are usually small, corrugated, surrounded by thickened capsules of connective tissue. The epithelium or the glomeruli themselves may be in a state of fatty degeneration; the latter are sometimes amyloid—some, as already mentioned, may have become calcareous.

The Interstitial Nephritis.

The change in the interstitial connective tissue may either preferentially affect the intercellular substance, which becomes thickened, hypertrophied, while the cells at the same time become larger, but only in a slight degree increased in number; or it may be the cells which the active irritation affects, multiplying by frequent subdivision, while the intercellular substance is not particularly increased. This last is, in general, a more acute process; in its extreme degree the cellular hyperplasia becomes rapid, the several elements as a result hereof becomes less and less, and at length assume the characters of pus-cells. The process then becomes suppurative; in its lower degrees a pale cellular hypertrophy takes place, which may exist as such for a long time, and finally, as in the first case, pass over into induration (sclerosis). A third but rarer result is the interstitial fatty kidney, where the newly-formed connective tissue passes over into fatty degeneration. The acute suppurative nephritis has nothing to do with this. The first form and the lower degrees of the second may be classed together under the denomination of

The Simple Interstitial Nephritis.—Sometimes the cells, sometimes the intercellular substance, are predominatingly increased; this lesion is either partial or general; it attacks both kidneys, and runs a chronic course. The connective tissue formed around the urinary canals contracts, and at the same time the small cysts already mentioned are often formed. The same takes place around the glomeruli; the connective tissue here becomes denser and denser, and begins to contract cicatricially; it is at the same time compressed, the circulation is partially or wholly obstructed; finally, the loops may coalesce, and the glomerulus then at length forms only a homogeneous mass; beside this they may be amyloid or in a state of fatty degeneration. The elements lying in the structureless capsule constitute the starting point of these new formations of connective tissue, not as Frerichs and Rokitansky, nay, even Virchow at an earlier period (*Archiv*, Bd. 4) assumed, a fibrinous exudation. Gradually as the contraction increases the whole kidney becomes much diminished, the tissue becomes sclerotic, tough, anemic; the surface is uneven, with most frequently considerable elevations and depressions; hence there is granular atrophy, the elevated parts corresponding to those least affected. With a uniform new formation and contraction of the connective tissue, a smooth atrophy may also in rare cases arise. Most frequently, as has already been stated, a parenchymatous nephritis is at the same time met with; but in what relation the two affections stand to one another, which is the primary and which the secondary, it is difficult to decide. Under the microscope the interspaces between the urinary canals are seen to be increased, filled with a sometimes more hyaline, sometimes more nucleated substance. As a result hereof the urinary canals are slender, of small calibre, sometimes constricted so as to resemble a string of beads; the tunica propria is often thickened and streaked. The glomeruli are seen to be surrounded with thick, concentric layers of connective tissue; they are small, of a homogeneous appearance, or in a state of greater or less fatty degeneration.

In our day, when interstitial nephritis is, so to speak, in fashion, we must, especially in the slight degrees, be very cautious in diagnosing it; it is well known that what we look for is only too easily found. It has already been stated how the distance between the urinary canals may, to a careless investigator, appear to be increased without being really so; but there are also other interstitial changes, besides the interstitial nephritis,

which in reality may increase the distance. In diseanes of the heart, and in general in all cases where there is a possibility of venous stases, the interstitial venous plexus in the kidneys becomes thus distended with the stagnating blood, the vascular walls are thickened, and the urinary canals are, at the same time, also compressed; in other cases the capillary nuclei may, in the same mode as has been described with respect to the glomeruli, during the amyloid degeneration, be increased; they will indeed then, in general, lie tolerably regularly in rows; but as it is impossible to distinguish them from the nuclei of connective tissue, it will be evident that the diagnosis may be extremely difficult, unless recourse is had to the chemical reaction; the difficulty will be still further increased when to such processes an interstitial nephritis is actually superadded

Hitherto, in speaking of the interstitial nephritis, we have referred only to the cortical substance; but the case is quite different in the pyramids, and when it becomes circumscribed (Nephrit. syphilit.). In the *pyramids* it occurs either more limited, as small greyish tubercles between the pyramids of Ferrein, consequently as a kind of small fibromas—or more universally along the urinary canals; the tissue contracts here also, as the cortical substance and the urinary canals; at the same time, much more frequently undergo cystoid degeneration. The result is a contraction of the pyramids, both in length and transversely, though mostly in the first direction. The pyramids may, at the same time, acquire some resemblance to what is found in hydronephrosis; but in this case the pressure has worked only superficially, it does not proceed from the tissue itself, and the contraction affects the longitudinal axis, while the transverse axis is elongated.

The *circumscribed* interstitial nephritis, or so-called syphilitic nephritis, occurs in several scattered points, and is usually of a purely interstitial nature. It corresponds completely to the processes occasionally observed in persons who, at one period of their life have suffered from tertiary syphilis, in the liver, lungs, and other organs. The affected parts contract, and finally only depressed cicatrices remain after old hemorrhagic infarctions of long standing, with which, probably, such a syphilitic kidney has often been confounded. The two affections are, however, distinguished from one another by the fact, that in infarctions are always found products of the metamorphosis of blood (pigment, crystals of hematoidin), while these are not met with in the interstitial nephritis. There still remains to be mentioned the rarer *interstitial fatty kidney*. In this case the kidney is in general large and flaccid; on the surface are observed yellowish or whitish striæ and marks, which, on section, exhibit themselves over the whole cortical substance; they form irregular figures, so that it may, even macroscopically, be inferred that the fact cannot be referred to the regular urinary canals, but that it lies externally to them. This form occurs pure, but extremely rarely, most frequently it is combined with amyloid or parenchymatous nephritis. It is, as has been mentioned, also supposed to be connected with syphilis. Under the microscope the urinary canals are seen pushed from one another, of diminished calibre; in the interspaces larger or less irregular fatty masses are deposited. Likewise the glomeruli, and in general the walls of the several vascular loops, are in a state of fatty or amyloid degeneration. The process may be compared with the atheromatous degeneration of the vessels, for in this case also the hyperplastic formations undergo a fatty metamorphosis.

Albuminuria, and, at least in the more advanced stages of the disease, diminished secretion of the urine have been enumerated as essential symptoms of the chronic renal affections, treated of in the foregoing paper; it is, therefore, desirable to see how these symptoms can be made to harmonize with the pathological changes just described It is well known that albumen exhibits only a very slight tendency to exosmose; but that such may take place, under increased pressure, is a settled point. Botkin's experiments with eggs (*Virchow's Archiv*, Bd. 20) which had been deprived, by means of dilute hydrochloric acid, of their calcareous shells, gave the following results:—An egg treated in this manner, and placed in distilled water, had, at the end of four days, allowed albumen to exude; but if, on the contrary, it were laid in a concentrated solution of chloride of sodium, no albumen was demonstrated in the solution, unless the egg, before having been laid aside, had begun to putrify. In the first case a portion of water presses endosmotically through the membrane, and, in consequence of the increased internal pressure thus produced, albumen again exudes. In the concentrated solution no such endosmose takes place, and, therefore, no exosmose; where putrefaction is commencing, on the other hand, the internal pressure is increased, and the albumen exudes. It has been said that the pressure to which the blood is exposed in the glomeruli must almost necessarily produce an exudation of albumen. This pressure is, in fact, exceedingly great; all the blood in the five or six vascular loops, of which the glomeruli are composed, is conveyed at the same time to the narrow exit, the vas efferens, which is not much wider than each single one of these loops. The pressure would be much greater still if the case were really such as is represented in most manuals, that the vas efferens is given off at an acute angle; but we have seen that this is not the case, and that, on the contrary, it is given off at an obtuse angle, and most frequently forms a curve, whereby the pressure produced by the interruption to the current of blood is somewhat diminished. Important and interesting as the question is, respecting the condition of the urine in the glomeruli, not only with reference to albumen, but also with respect to its reaction, whether this be alkaline, which is, perhaps, most probable, or acid, from

the beginning, it is scarcely possible to arrive at any certainty upon the point. Although this assumption respecting the physiological separation of albumen in the glomeruli is purely theoretical, there is still something in its favour. As the normal urine does not, in fact, contain albumen, the latter must again disappear in the urinary canals, and we are, therefore, naturally led to seek the intervening agent in the epithelial cells; if these are, however, morbid, and not in a condition to execute their depurating part, albuminuria is a necessary result. In the physiological state, too, we may find an argument in favour of this view, namely, in the structure of the epithelium already spoken of; the latter is in the section of the urinary canals, lying next to the glomeruli, rich in albuminates, which gradually diminish and almost disappear in the tubuli recti.[a] Against the occurrence of this separation in the glomeruli, on the other hand, the pathological fact is decisive, that in the extreme degrees of nephritis and amyloid degeneration, where the glomeruli are all but destroyed, and, at all events, cannot be supposed to allow the albumen to transude through their walls, great albuminuria still exists. We are consequently led to refer this transudation of albumen to another section of the vascular system, namely, the interstitial capillary net-work, that is, we turn from the more secreting to the more nourishing section. That it is in this case the increased lateral pressure which brings forth the albumen, is shown also by Frerichs' experiment of tying the aorta below the renal artery. If, that is to say, the glomeruli were the place where the albumen is separated, we should, since the pressure must here first affect the glomeruli, have a considerable albuminuria—but this is not the case; it appears, on the contrary, that the latter occurs most abundantly when the efflux of the blood is arrested, as when the renal vein is tied, that is, where the increased lateral pressure particularly affects the interstitial venous net-work. Yet we cannot, therefore, say that the albumen is excreted solely in this place; it is still possible that it may also, in some cases at least, be eliminated in the glomeruli; indeed it is even possible that the large epithelial cells abounding in albumen during the nutritive change, which suffer in the parenchymatous nephritis, might eliminate albumen. Still, disturbances in the circulation remain to be considered as the most essential source of albuminuria, and closely connected with it, whether the cause of these is to be sought in the vessels immediately belonging

[a] Should this theory prove to be well founded, it would go to explain, and would also receive support from, the fact observed by myself, of the very frequent, if not invariable occurrence of albumen in the urine of the human fetus. Of thirteen specimens of fetal urine, which I have on different occasions examined, all were more or less albuminous. See experiments in Dr. M'Clintock's paper, "On the Presence of Urea in the Liquor Amnii," in Vol. vii. of the present series of this Journal, p. 39; and also "Experiments as to the Existence of Sugar in the Urine of the Fetus," by W. D. Moore, M.B., in Vol. xx. of the same, page 88.—*Translator.*

to the kidney, or in more general disturbances, as cardiac and pulmonary diseases. We may, therefore, also have passing albuminuria of a purely transitory nature, where a mechanical pressure acts for a time on the large vessels (the aorta or vena cava), as we often see during pregnancy. In the chronic renal affections, treated of in this paper, we have also seen the venous stases to be a constant symptom; only in the amyloid degeneration, so far as it is not complicated with any more considerable parenchymatous or interstitial nephritis, is the case somewhat different. Here the cortical substance becomes anemic, on account of the diminished supply of blood, through the degenerated glomeruli, but at the same time the interstitial capillary net-work is, precisely for this reason, under an increased pressure, and the albuminuria may, therefore, be supposed to proceed from this source. The diminution in the secretion of urine, of course, depends upon the state of the glomeruli. Even if these are still acting, their calibre may be so diminished that only a small quantity of blood can traverse them, and their walls may be so changed that only a smaller quantity of material than ought to do so is in a condition to pass through them, and it is precisely such matters as ought to be excreted, and which constitute the most essential constituents of the urine (urea, uric acid) that are retained; hence a diminished, and at the same time, qualitatively altered, urine will be secreted. In other cases, where the glomeruli are not altered, or, at all events, are inconsiderably so, the urine will not be qualitatively, or even quantitatively altered, but will only carry off the abnormal albumen.

Finally, in conclusion, some remarks upon the so-called fibrin-cylinders, which were formerly considered to be a sign of inflammation, as a fibrinous exudation from the hyperemic vessels, whence the name derived from a time when all kinds of albuminates were called fibrin on account of the similarity of their reaction; the decisive character of fibrin is the fibrillar form in which it coagulates. Were they really an inflammatory product they should always be met with, and precisely in those places where the inflammation is most strongly marked; but this is not the case. It has already been casually mentioned that they are found principally in the straight tubes in the pyramids, more rarely in those of the cortical substance, and scarcely at all in its proper convoluted tubes, and that they are often situated in the constrictions and in the small microscopic cysts. Their origin is very obscure; according to Key, their formation depends on a change in the albumen of the epithelial cells. Virchow, too, inclines to this view. They scarcely even consist of fibrin, although Beckmann and Virchow sometimes saw a fibrillar structure; they are most nearly analogous to the so-called colloid mass. They appear at one time quite pale, shining, transparent, at another slightly inclining to yellowish; in other cases they enclose the discolourized blood cells, pigment, finely divided fat, epithelial nuclei, and other remains of epithelium;

they often pass away with the urine, when they do not lie in too strongly constricted places; if they lie in the small cysts, they gradually dissolve in the contents of the latter. Although the fibrin cylinders occur frequently in the parenchymatous nephritis, too great or too decisively diagnostic importance ought not to be attached to them. The cylinders occurring in papillary catarrhs are formed of mucin, and are purely catarrhal secretions.

[*From the Transactions of the Ethnological Society.*]

XXVI.—*Observations on a Systematic Mode of Craniometry.*

By GEORGE BUSK, F.R.S., F.L.S., etc.

IN the following observations, I can claim but little originality, seeing that the system of measurements of the cranium proposed for adoption, or rather, on the present occasion, for discussion, differs but little except in amplification from that propounded by Professor v. Baer, in a paper in the *Mémoires de l'Acad. Imp. des Sciences de St. Petersburg*, 6me ser., t. viii, in which he describes the characters of various Asiatic and other crania, contained in the anthropological collection in that city. To these measurements I shall afterwards refer.

But before entering upon the immediate subject I am desirous of bringing before the Ethnological Society, I would premise a few words respecting the present value of craniometry in the study of ethnology; that is to say, as to the assistance we may thence derive in the distinguishing of the varieties of the human race. For, whatever opinions may be entertained on the subject of unity or plurality of the human species, it cannot for a moment be denied that permanent, and in their extreme forms, well marked *varieties* of men have existed from all historic times, and are found at the present day, on the face of the earth. That these varieties are distinguished by well marked physical and important psychical characters, cannot be denied. Our object, however, on the present occasion, is simply to inquire into the value of a single character selected from the former category, and whether, and how far, this single character can be relied upon, in the absence of others, to enable us to distinguish one variety of mankind from another.

One reason for the selection of the cranium for this purpose, arises from the circumstance that, of all the individual portions of the bony skeleton, none in the first place is so thoroughly characteristic of man; and secondly, because there is none, speaking generally, which presents such well marked diversities in different races of mankind.

In viewing any collection of crania, the most unobservant will be struck with the fact that the specimens, if sufficiently numerous, may be divided into groups marked with distinctive characters. One set of skulls will be found nearly or quite as broad as they are long, whilst in another the length will considerably exceed the breadth. In some the jaw, with the teeth, or the lower part of the face, will be seen to project, so as to approach the elongated muzzle of an ape, whilst in others the perpendicular profile will, from old associations, persuade us that we are looking upon a more perfect or elevated type.

These broad distinctions, and several others, such as a greater or less height, an oval or oblong, a triangular or rounded outline of the cranium when viewed from above, a greater or less width and difference in position of the cheek bones, a uniformly arched or a pyramidal form to the upper part of the skull—all these characters will be obvious enough to the casual observer; and when he is told that these various forms have been found by observation to be peculiar to particular races or to particular regions, and that, so far as investigation has extended, they are as permanent and as unalterable by external conditions as any other characters that can be pointed out, no one will deny that it is an important problem in the natural history of man to determine how far these and other less obvious characters may be so expressed as, in the absence of the objects themselves, to enable others to appreciate them; and so defined as to admit of accurate or approximately accurate comparison *inter se.*

The present attempt is justified, perhaps, by the fact that at the present time, as is said by Professor Wagner, in a recent memoir on this subject, "we possess no exact methods of estimating the morphological relations of the cranium, or of expressing them in clear and definite terms."

This deficiency has not arisen, however, from want of attempts to carry out such a design, but, as it seems to me, from the methods never having been conceived in sufficiently general terms.

The study of the human cranium, in an ethnological sense, is a recent one, and may be said to date from Blumenbach: that eminent physiologist, however, was contented with a survey of the general form of the skull, and appears to have devoted little or no attention to any systematic measurement of its dimensions. Since his time, various modes of measuring the cranium, and of ascertaining its capacity, have been proposed for different purposes. Some very ingenious, but most of them so complicated and inapplicable, except for the special purposes in view of the proposer, that it may truly be said, as asserted by Professor Wagner, that we are as yet without a generally adopted mode of making comparative craniometrical measurements.

Since Blumenbach, the most important researches on the subject of ethnological craniology have been those of Professor Retzius of Stockholm, whose early death science has recently had to deplore, and of the illustrious Professor v. Baer of St. Petersburgh, in whose steps I began by saying I was but a humble follower.*

One important benefit was conferred upon craniology by Professor Retzius in the proposal of terms, since almost universally adopted, by which certain of the more strongly marked of the varieties of crania, I have before adverted to, are commonly designated. It is to him that we owe the terms *brachycephalic* and *dolichocephalic*, with their respective modifications of *orthognathic* and *prognathic*, and under which, in a certain sense, all the forms of human crania may be classified. His great merits in other departments of ethnology it would be out of place here to touch upon.

* Davis, Van der Hoeven, and others.

Useful as these terms have been found, as expressing a certain collection of facts, it cannot be denied that they are wanting in precision. Professor Retzius nowhere, so far as I am aware, gives any terms or figures by which the proportions constituting a dolichocephalic or a brachycephalic cranium can be distinguished, nor any strict criterion which may determine an observer, in a doubtful case, to *place* a cranium in the one class or the other; and the same may be said of the varying degrees of height of the cranium, of prognathism, zygomatic width, and so on. One object I have had in view in the scheme of measurements now proposed, is that precise numerical values should be employed in place of words, in speaking of the proportions of a cranium; or, at any rate, that any term employed should be associated with some given numerical value.

This idea, or something like it, though I cannot find that he has openly expressed it, appears to have been entertained by Professor v. Baer, who seems to have been the first to express the proportions, or some of the proportions, of a cranium in terms of a common module. It is only recently, upon consulting his memoir above referred to, that I was aware of this fact, and I have been gratified in finding that I was preceded by so eminent a guide in the selection of the length of the cranium as the module in question. It will readily be seen that by the adoption of this plan, though whether the length or any other dimension, the standard of measure may be left for the present undetermined, the comparative length or shortness of a skull may be accurately expressed in figures. As, for instance, assuming the length as the standard, crania as regards their length may be said to have the breadth as ·6, ·7, ·8 or ·9 of the length, the two former numbers actually embracing all the crania hitherto classed under the dolichocephalic type, whilst under the two latter will be found included all the so-termed brachycephalic skulls. By reference again to the same module, the degree of prognathism, or of occipital projection, of height, of zygomatic breadth and so on, may also readily be expressed, and placed in columns in a table, so that the comparison of one set of forms with another, and their average values, may be seen at a glance.

Professor v. Baer divides his table of measurements into 13, or, more properly speaking, into 19 columns, thus arranged:

1. The length of the cranium, measured from the glabella to the most prominent point of the occiput, unless that happen to be an inordinately developed spine.

2. Its height, measured from the plane of the foramen magnum to the highest part of the vertex.

3. The width, measured wherever it may be greatest; the position of this part being indicated by the point in a vertical line, drawn from the centre of the auditory foramen to the vertex, notice also being taken whether it be before or behind this line.

4. The width of the frontal bone, at the narrowest, that is to say, at the anterior, and at the widest part.

5. The parietal breadth, measured from one parietal protuberance to the other.

6. The zygomatic breadth.

7. The horizontal circumference of the cranium.

8. The vertical arch, as he terms it, subdivided into three portions; but for what reason he has adopted the peculiar subdivisions he has, I cannot explain.

9. What he terms the *longitudo racheos*, or *longitudo corporum vertebrarum* ex quibus calvarium constitutum est. This means the distance from the anterior border of the foramen magnum to the fronto-nasal sature.

10. The transverse circumference of the calvarium at the junction of the parietal and occipital regions, indicated (*a*) by a line drawn round the occiput on a level with, and, I presume, slanting from the centre of the auditory foramen to the other. (*b.*) The transverse diameter or greatest chord of the occipital arc.

11. The distance from the centre of the auditory foramen to the middle of the glabella, and from the same point in the auditory foramen to the most distant part of the occiput. The comparison of these measures "indicates," he says, "the evolution of the occiput."*

* In their admirable work, the *Crania Britannica*, Messrs. Davis and Thurnam employ the following measurements: 1. Horizontal circumference; 2. Longitudinal diameter; 3. Frontal region—(*a*) length, (*b*) breadth, (*c*) height; 4. Parietal region—(*a*) length, (*b*) breadth, (*c*) height; 5. Occipital region—(*a*) length, (*b*) breadth, (*c*) height; 5. Intermastoid arch; 6. Internal capacity; 7. Face—(*a*) length, (*b*) breadth. Most of the above will be found included in my scheme; the only omission of importance in that, perhaps, being the internal capacity; but this, I think, is hardly worth the trouble of ascertaining. The chief point, as it seems to me, being to determine the relative dimensions of the three great cranial regions. The gross capacity varies, of course, according to the size of skull, which may differ very widely, even in well marked crania, of one and the

I will now proceed to describe the measures I have been led to adopt, and it will be seen that my system is in a great degree borrowed from, and coincides with, that of Professor v. Baer, though the principles upon which they are respectively based are not, perhaps, exactly identical. What I have had chiefly in view was to continue to place in as few columns as possible such measurements as might be readily made, for the most part, even in imperfect skulls, and what may yet suffice to shew,

1. The proportions of the entire *cranium*, as regards *length*, *breadth*, and *height*.

2. The comparative capacity, or size rather, of the *frontal*, *parietal*, and *occipital* regions, corresponding to the main divisions of the brain.

3. The degree of pro-or orthognathism, and of the occipital projection, and, inferentially, to indicate the position of the *foramen magnum*; and

4. By the comparison of two measures, that is to say, of the length of the nasal radius (mihi), (*cranial vertebral axis*, v. Baer), with that of the maxillary radius, to arrive at some notion of the facial angle, which, without the aid of a complicated and expensive apparatus, such as the ingenious instrument of M. Jacquart, it is difficult, if not, in some cases, impossible, to estimate with any approach to accuracy.

The measurements I propose may be arranged in a tabular form in 23 columns, beyond which several others may be left for the insertion of the *proportions* of the various dimensions to each other, calculated in terms of a common standard or module, for which, as before said, the *length* of the cranium may be conveniently taken.

Besides these, in some printed tables drawn up by myself and the late Professor Quekett, five more columns are added, for the facial angle and the various proportions of the lower jaw, upon which Professor Quekett placed considerable value.

The first 14 columns contain all the measures which require a single instrument fitted to measure the distances between two points in a straight line. Various contrivances, of course, may be used for this purpose, such as callipers, compasses, etc.; but in practice I have found that the proceeding is much facilitated

same race, depending, in great measure, upon the stature, or size, of the individual. Thus, the Negroes of the Cape de Verd Islands, who are generally very tall and strong men, and several races of continental Negroes of large size, have very capacious crania, in which, however, the Ethiopian character is as well expressed as in the smaller ones.

Many other lists of measures might be given; but I have stated enough to show that, at present, no uniform system has been adopted by Ethnologists in general.

by the employment of a simple instrument constructed on the principle of a common shoemaker's gauge, and consisting of a straight stem about twelve inches long, having an arm jointed to it at one end, which can be opened out to an exact right angle, and a second arm which can be slid up and down the stem, also at a right angle. These arms should be about six inches long, and the whole should be made sufficiently strong and rigid that the parallelism of the arms may be perfectly maintained under moderate pressure upon an object placed between them towards their free ends. The best material, as being the lightest, is boxwood; and I have found that a width of about one inch, and the thickness of an ordinary foot rule, are quite sufficient. The stem should be graduated in inches and tenths on one side, and in centimeters and millimeters on the other, so that either the English or the French measure may be used *ad libitum*. The graduation, of course, should commence from the fixed arm. Each arm should also be graduated in the same manner, the graduation starting from the stem. With this simple craniometer all the measurements in the first columns may be very quickly taken. But it will be convenient to say a few words respecting what I have termed the *radial* measures. In making these measures, as for other purposes afterwards to be adverted to, I, following v. Baer, take the centre of the *external auditory foramen* as the starting point. In order to ensure accuracy in the length of the radial line, it is, of course, necessary that it should be measured in a direction parallel to the vertical longitudinal plane of the skull, and this I have found can only be done with facility and correctness in one of the following ways:—It may be done either by fixing a small conical cork in each auditory foramen, supporting a needle in its centre, which will project about an inch from the side of the skull. If the craniometer with both arms at a right angle to the stem be then placed with the stem upon the point to which the radial line is to be measured, and the arms are brought down on each side over the auditory openings, the needles on either side ought to point to the same degree of the scale on each arm if the arms are parallel to the mesial vertical plane, and the degree pointed at will be the radius sought; or 2, a small sliding piece may be made to fit on each arm, having a conical plug, to be inserted into each auditory opening, which will answer the same purpose as the cork and needle, with perhaps greater certainty.

The measurements in the next nine columns are all made with the measuring tape. The manner of taking them is too obvious to require any special remark.

But another part of the subject, in my opinion even of

greater importance than the taking of measurements, is a method of making such *delineations* of the cranium as may be relied upon for its accurate comparison with others. Of the numerous, and many of them admirable, representations of human crania hitherto published, few or none that I have seen suffice to show the actual forms and dimensions in such a way that direct comparisons can be made between different figures in these particulars.

The object, as it seems to me, to be held in view in preparing figures of crania for ethnological or similar scientific purposes, is, 1, that the cranium should invariably be represented in a certain defined position; 2, that it should be drawn either of the natural size, or reduced to a given proportion, alike in all cases; 3, that so many figures should be given as, without any perspective, may afford a sufficient idea of the outline of a section of the cranium in the three dimensions of *length*, *breadth*, and *height*, together with a view of the *face* as seen in front, and of the *base* regarded as in a horizontal plane. Five figures of a skull, consequently, are indispensably requisite to afford an adequate idea of its conformation and dimensions, so far as that can be derived from any mere delineation.

The above objects I have endeavoured to carry out in the following manner:—

1. *Position of the Cranium.* Stretch the measuring tape from the centre of the left auditory opening to the junction of the sagittal and coronal sutures, and along it draw a pencil line. This line, which, so far as I know, was first suggested by l'Abbé Frère, may be assumed to represent the *vertical line*, and it serves as the invariable standard of position.

2. A line at right angles with the vertical, and crossing it at the centre of the auditory foramen, I regard as the *horizontal* or *base line* of the cranium; and it will be found to coincide pretty nearly with the base line of most writers, and to be nearly coincident in most cases with the floor of the nostrils. Any remarkable deviation in this respect will be worthy of remark.

With respect to the size of which crania should be represented, convenience alone would suggest that one below the natural should be adopted; and, for all the purposes contemplated in this paper, it would appear that they will be answered by figures half the size of nature as well as by larger ones, which, though occupying four times the space, are not a whit more useful, nor, in fact, more natural, when we consider the usual distance at which a skull and a drawing of a skull are respectively viewed. I therefore propose that all figures of crania should be drawn to a scale exactly one-half the size of nature.* The cranium then being placed by any convenient contrivance with the vertical line perpendicular, and with its left side towards the observer, the camera lucida is placed at the proper distance, and so and at such a height that the centre of the prism is opposite the vertical line, and on a level with a spot midway between the base of the skull and the vertex. The side view having been thus taken, and found by actual measurement to agree with the truth, the skull is turned round in the same horizontal plane and level, so that the back is presented to view, and at such a distance that the breadth in the figure is found by measurement to agree with the actual greatest breadth; the figure when drawn will therefore represent the transverse vertical section of the skull at its widest part, as the former shows its longitudinal section. Without otherwise altering the position of the cranium upon its support, it is then turned round so as to present the face to the observer, and placed at such a distance from the camera that the measured distance between the external orbital processes of the frontal bone agrees with the figure thrown on the paper by the camera. The drawing, in this position, affords a view of the shape and comparative height of the forehead, the form of the orbits, and of the nasal opening, etc. The skull is now to be placed and supported on the occiput, the vertical line being made horizontal, and the centre of the prism made to coincide with the level of the vertical point—that is to say, the junction of the sagittal and coronal sutures. In this position, figures are taken, 1, of the vertical view, the outline corresponding by measure with the greatest breadth; and 2, of the base (without the lower jaw), which latter view is taken at such a distance that the space between the points of the mastoid processes is found by measure to agree with the figure projected on the paper. This aspect will present the shape and width of the maxillary arch, the position and form of the foramen magnum, etc.

I cannot conclude without apologizing for the length of time I have occupied your attention upon so dry a subject; but have thought that, to make it of any interest, or the discussion of any utility, it was necessary to enter into minute details which could not fail to be tedious in the recital, though requisite for the full understanding of what I was desirous of bringing before the Society.

* It is my intention shortly to bring out the first decade of "*Crania Typica*," with a view of showing the way in which this plan might be carried out.

CASE

OF

PROGRESSIVE ATROPHY

OF THE

MUSCLES OF THE HANDS:

ENLARGEMENT OF THE VENTRICLE OF THE CORD IN THE CERVICAL REGION, WITH ATROPHY OF THE GRAY MATTER: (HYDROMYELUS).

By WILLIAM GULL, M.D.

The following case is given as a contribution to the pathology of "progressive muscular atrophy."

Three classes of cases are as yet confused together under this term, and its synonym, "wasting palsy."

Progressive, or perhaps better, "excessive" muscular atrophy, may arise from primary lesion of the muscular elements—or from lesion of the trunks or branches of the nerves—or from morbid changes in the gray matter of the cord. It is the difficulty of distinguishing the primary seat of disease in each of these classes of cases, which has led to exclusive, and therefore erroneous views of their pathology, one observer maintaining that progressive muscular atrophy is always a peripheral affection, whilst another asserts that it has constantly a centric or spinal origin.

Besides the forms here enumerated, there is a fourth class, in which muscular nutrition fails from a morbid diathesis,

allied to rickets. It has nothing in common with the pathology of the former cases but the want of muscular power. Dr. Meryon's[1] are good examples. I have seen the disease in two girls of one family. It is a malady beginning in, and limited to childhood, and peculiar to it. The muscles are not diminished in bulk at the commencement of the disease, nor is there necessarily any paralysis during the whole course of the case, but only a lentor and feebleness of movement. This cursory mention of such cases is sufficient to show with what little practical value they can be included in the first enumeration. No doubt much of the obscurity which at present besets this subject is favoured by the assumption, that where disease was not discovered in the cord, it did not exist; happily, however, positive assertions from negative evidence are at this day considered of less weight. We cannot peruse recorded cases of progressive muscular atrophy, without feeling how unsatisfactory, in most of them, is the post-mortem examination of the cord, and must hesitate to accept the conclusion that it was free from lesion, because none was discovered. Dr. Beale's 'Archives' (No. 9), contain an almost critical case in illustration of these remarks, and certainly, but for the rare skill of Mr. Lockhart Clarke, it might have been recorded as one of muscular atrophy, the cord being healthy. Thanks, however, to the means we possess of investigating ultimate structure, Mr. Clarke was able to show that there were certain areas of the gray matter which had undergone marked change of a morbid character, although the cord had an entirely healthy appearance. During the life of the patient referred to, there was a difference of opinion as to the primary seat of the malady, and but for such an exhaustive examination as it received after death, instead of its being a contribution to our knowledge, the record of the case would have served only to give strength to false assumptions, and fortify us in the error of assuming that all is sound where imperfect examination detects no weakness.

The following case, on its entrance into the hospital, gave rise to the same question; whether the muscular atrophy had a peripheral or central cause. The patient was a journeyman tailor, working hard at his business in London, and, therefore,

[1] 'Med.-Chir. Trans.,' vol. xxxv, p. 73.

of necessity using the muscles of his hands in an extreme degree. Here, therefore, was a possible, and not an improbable cause of a primary affection of the muscles themselves, but, as was remarked in a clinical lecture given on the case, it was to be remembered that the will does not directly act upon the muscles in voluntary movement, but upon the gray matter of the cord to which the nervous filaments are connected, and therefore, that it is as reasonable to infer a lesion of the gray matter from over-work, as of the muscles.

The first symptom, in this case, was inability to extend the little and ring fingers of the right hand, with a sense of coldness and numbness in the part. This was the only complaint for eleven months, and, no doubt, if the patient had been seen during that time, it might have been thought more probable by some that the disease lay in the muscular tissue than in the centre of the cord. It was not until after eleven months, that the adjoining middle finger began to fail in a similar way. A perusal of the case will show, that the centre of the cord had by this time undergone extensive changes, yet it was not until the left hand became affected, that the central character of the lesion began to appear, and even then it might have been contended, that the symmetry of the muscular affection was owing to the same conditions of over-wear in both hands. Had it not been for typhus fever, which then prevailed with unusual virulence in the hospital, we should not have known how great morbid changes the central gray matter of the cord may undergo, with but slight and limited, and only slowly progressive peripheral effects. The lesion discovered after death was evidently in no way connected with the attack of fever, nor in any way affected by it. The tissues at fault showed no traces of recent activity about them. This case is therefore another instance of atrophy progressing from muscle to muscle in the slowest way, and unattended by any of the common proofs of central disease, though depending upon it.

It also suggests some doubt respecting the validity of the present theories of the function of the gray matter of the cord. A glance at the annexed plate of a transverse section of the cord in this case, will show how large a part of the gray matter may be slowly removed, without affecting sensation to any corresponding extent, and without disturbing the general

functions of the cord, or the influence of the brain upon the parts below.

Although there were no other remains of the gray matter in certain parts of the cervical region but the anterior cornua, the patient was still able to walk perfectly well, and to move the arms freely in all directions, and the sphincters were good, nor was there any affection of sensation in any part, except a feeling of numbness in the right hand.

What the nature of the change in the cord was, may be a matter for speculation. So far as it affected the gray matter, it seemed to be no more than atrophy from distension of the ventricle of the cord, by an accumulation of fluid in it. A chronic cervical *hydromyelus*, comparable to a chronic *hydrocephalus*.

It is noticeable that normal epithelium still lined this extremely dilated ventricle.

The appearance of a distinct membrane to the cavity was produced by condensation of the normal textures pressed outwards, and not by any new plasma.

The extent to which the disease reached in a longitudinal direction, is shown in the woodcut, the dotted outline in the middle of the cord indicating the extent and form of the cavity in the interior.

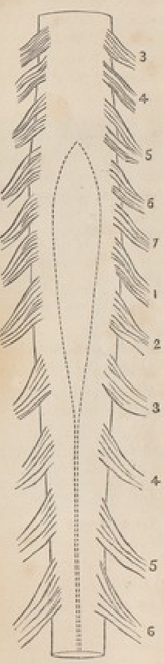
The greatest diameter of the cavity was opposite the origin of the seventh or last cervical nerve, and hence the peripheral effects were chiefly marked in the branches of the ulnar nerve, which here has its principal origin.

The form of the cavity, on a transverse section, is shown in the plate. It will be observed that it was not a simple circular dilatation, but corresponded to the general disposition of the gray matter and its cornua.

G. B—, æt. 44, a journeyman tailor, of sober habits, was admitted into the clinical ward, February 5th, 1862. States that he has always been healthy and strong. Never had any injury to his back. Thirteen months ago, when working in London, the fourth and little finger of the right hand became weak and flexed, without any assignable cause. The hand was cold, and there was a feeling of numbness in the fingers, but no pain. This give rise to a good deal of inconvenience, but he was able to continue working at his trade. Two months ago, the middle finger of the same hand became suddenly affected, and three weeks ago the three inner fingers of the left hand became weak and flexed in the same way, but without any numbness. The hands gradually wasted. The arms are not affected. Seven weeks ago he had pains through his chest, and a feeling of tightness across the upper part. He is pale, complains only of wasting and weakness of the hands; has no pain in them, but the right is cold, with a feeling of numbness. The left hand is not so cold, and the sensation in it is perfect. He can move both thumbs and index fingers freely; he can also extend the first phalanges of the other fingers of both hands, but not in the least degree the second and third phalanges, which are gently flexed towards the palm. The interosseous spaces on the backs of the hands are sunken from the wasting of the muscles. The palms of the hands are hollow, and the flexor tendons very prominent. The thenar eminences are wasted, and the hypothenar almost entirely gone, particularly on the right side. The motion of the wrist joints is unaffected. He can move the arms freely in all directions. Can walk perfectly well.

At the upper part of the dorsal region there is slight flattening of the natural curve of the spine, from the long muscles of the back being at this part wasted. Pressure on the fourth dorsal spinous process causes a sharp, pricking pain, as of a knife running into the part, but when the part is not touched he has no pain. No pain on pressing the other spinous processes; no affection of sensation in any part, except the feeling of numbness in the right hand; sphincters good; urine normal; appetite and digestion good. He was put upon a full diet, and the wasted muscles were daily galvanized by an intermittent current. A fortnight after admission he had gained power in the hands. He said he felt them stronger and more pliable after each application of the galvanism. It was noted that, with a moderate current, the contractility of the muscles of both hands was good, but more particularly in the short muscles of the thumb, which were least wasted. Sensibility not so acute in the right hand as in the left, but no marked anæsthesia of either. Both hands were rather cold. A few days after this report the patient sickened with typhus fever, and died on the 8th of March.

A post-mortem examination was not permitted at the hospital, and it was only after much difficulty that the cord could be obtained. The bones and ligaments of the spine were healthy; the membranes of the cord healthy; the exterior of the cord presented nothing abnormal, except that the cervical enlargement appeared broader and somewhat flattened. On making transverse sections, the white columns had their normal consistence and texture, but the centre of the cord had a large cavity, beginning at the fifth cervical, enlarging downwards to the seventh, and from thence tapering as in the accompanying woodcut. The appearance of the cord on a transverse section at the origin of the seventh cervical nerve is shown in the annexed plate. It will be seen that the only remains of the gray matter are at the anterior part of the cavity behind the anterior columns. Here the caudate vesicles had their normal size and structure; the pigment, nucleus, and nucleolus being well marked, and the tubular structure unaltered. The cavity in the cord was bounded by a layer of condensed gray substance, which could be separated as a distinct membrane. On its interior surface, forming the lining of the cavity, were a number of delicate, elongated, nuclear bodies, apparently epithelium. One or two granule cells were found scattered amongst the white columns, but no further traces of any active tissue change. The roots of the nerves appeared normal, and contained healthy tubules. The character of the fluid filling the cavity could not be ascertained, as it escaped in the removal of the cord from the spinal canal.



PLATE

Illustrating Dr. GULL's case of Enlargement of the Ventricle of the Cord in the Cervical Region.

Transverse section of the spinal cord, at the origin of the seventh cervical nerve.

The centre of the cord was hollowed out into an irregular square cavity or ventricle, with cornua corresponding to the general disposition of the gray matter.

This cavity was limited by condensed gray matter, and lined by an imperfect epithelium.

Towards the posterior columns, and at the origin of the posterior roots, it will be seen that little, if any, gray matter was left.

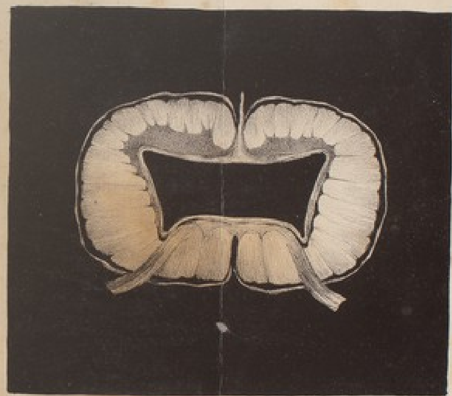
Anteriorly, the gray matter is spread out, and in it, by the microscope, the caudate vesicles could be seen, having their normal structure.

The white columns are shown in the drawing a little disintegrated, and irregularly spread out, owing to the thinness of the section.

They had quite a normal structure, except that, after repeated examination, one or two granule cells were detected in them.

The membranes surrounding the cord, shown in outline in the plate, were healthy.

Plate



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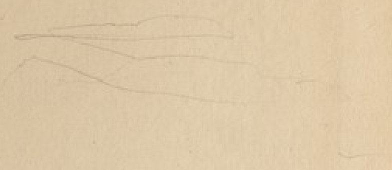

PAMPHLETS

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