PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

VOL. I.

MDCCCXLI—MDCCCXLIV.

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MDCCCXLIV.

CONTENTS.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTIETH SESSION, 1841-42.

CONTENTS.

The Philosophical Society of Glasgow was founded on the 9th of November, 1802. Three gentlemen of that city, Messrs. John Roberton, William Douglas, and Peter Nicholson, considering that general advantage would be derived from the establishment of a society for the discussion of subjects connected solely with the arts and sciences, issued a circular, dated 5th November, 1802, to their fellow-townsmen, requesting such as favoured the scheme, to attend a meeting on the 9th of the same month. Accordingly, on that day the following gentlemen convened at the Prince of Wales' Tavern:—Dr. William Meikleham, Messrs. James Monteith, John Roberton, William Douglas, James Cook, William Mitchell, William Dunn, Robert Kibble, Robert Thom, David Hamilton, Peter Nicholson, James Hardie, James Scott, Andrew Brocket, John Buttery, John Smith, James Boaz, James Haldane, Alexander Galloway, Alexander Drummond, James Chrichton, William Reid. Such were the original members who constituted the first meeting. Their number, however, speedily increased to sixty, and comprehended many individuals who have since acquired prosperity and reputation.

From that period to the present, the society has continued with varied success to hold meetings either weekly or every fortnight. The minutes of the society have been carefully preserved, and exhibit throughout, on the part of the office-bearers and secretaries, much care in conducting the business, and in recording the transactions of the society. The presidents were often chosen annually; the secretaries have, however, been more permanent office-bearers. Mr. James Boaz continued in the office of secretary from 1804, till his death in March 1830. His minutes are written with great neatness, and contain abstracts of papers, and drawings of models or plans which have accompanied descriptive communications.

Although the society does not appear, at any period of its history, to have published even abstracts of its proceedings, yet several of the communications read at the meetings have appeared in the scientific journals of the day, or in the transactions of other philosophical societies. It has been suggested, during the present session, that an occasional publication of notices of the papers read at the society, might contribute to extend the usefulness of the institution, and perhaps to elicit contributions which have hitherto been withheld from the absence of a convenient medium for publication. In accordance with this view, the present sheet is now printed.

MEMBERS OF THE PHILOSOPHICAL SOCIETY OF GLASGOW,

APRIL 20TH, 1842.

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1802, Nov. 1, Professor Meikleham.
1802, Nov. 9, John Geddes.
1802, Nov. 9, Henry Houldsworth.
1802, Nov. 9, Charles M'Intosh.
1802, Nov. 9, James Sword, jun.
1804, Dec. 19, John Thomson.

1810, Dec. 24, William Freeland.
1814, Dec. 19, Thomas Muir.
1815, Feb. 27, James Lumsden.
1816, June 3, William Dixon.
1818, Jan. 12, Archibald Geddes.
1818, Jan. 12, William Waddell.
1819, May 24, Andrew Liddell.
1820, Feb. 21, John Hart.
1820, Feb. 21, Robert Hart.
1820, Feb. 21, Alexander Watt.
1820, May 1, James Edington.
1820, May 1, Gavin Inglis, Fife.
1820, May 22, Alex. Johnston, Dublin.
1820, June 12, Nichol Handyside.
1820, Aug. 21, John Herbertson.
1820, Nov. 20, John Steel, Greenock.
1821, Jan. 22, Peter Aitken.
1821, Feb. 25, Daniel Wilson.
1821, July 16, John Ure.
1821, Aug. 6, George Watson.
1821, Dec. 17, And. Smith, Mauchline.
1822, Aug. 5, John Brash.
1822, Oct. 14, John Stewart.
1826, June 5, Chas. Chalmers, Edin.
1826, Nov. 20, Professor Wm. Couper.
1827, Jan. 7, John Eadie.
1827, March 5, Alexander Hastie.
1827, April 30, William Ewing.
1827, July 30, James Eadie.
1828, Jan. 7, James Davidson.
1828, May, 5, John Gibson.
1831, Jan. 17, George Smith.

1834, Feb. 10, Dr. James Brown.
1834, Feb. 10, Professor A. Buchanan, M.D.
1834, Feb. 10, Professor Thos. Graham, London.
1834, Feb. 10, Dr. A. J. Hannay.
1834, Feb. 10, J. Scouller, M.D. Dublin.
1834, March 10, Richard Cunliffe.
1834, March 10, John Leadbetter.
1834, March 10, Daniel Mackain.
1834, April 7, John Joseph Griffin.
1834, April 7, Alexander Harvey.
1834, May 19, Walter Crum.
1834, Nov. 12, Professor T. Thomson, M.D.
1834, Nov. 26, Henry Inglis.
1835, Jan. 7, John A. Fullarton.
1835, Jan. 21, Jas. Davidson, Ruchill.
1835, March 4, James Buchanan, jun.
1835, March 4, John Campbell, Surgeon.
1835, March 4, Allan Fullarton.
1835, March 4, Robert M'Gregor.
1835, April 1, John White.
1835, April 5, John Houldsworth.
1835, May 13, John Baird.
1835, Nov. 4, John Wilson, Thornlie.
1835, Dec. 2, Henry Paul.
1836, Feb. 10, Archibald M'Coll.
1836, Feb. 10, James B. Neilson.
1836, March 9, Thomas Dawson.
1836, March 9, John Liddell.
1836, March 23, Professor J. P. Nicholl.
1836, Nov. 16, Graham Hutchison.
1836, Nov. 16, C. Randolph.
1836, Nov. 16, John Thom.
1836, Nov. 30, James Lumsden, jun.
1836, Nov. 30, T. Thomson, jun., M.D.
1836, Nov. 30, John Tennent, Campsie.
1837, Nov. 1, James Young.
1837, Nov. 15, John Stenhouse, Ph. D.
1837, Nov. 29, Dr. William Gregory.
1837, Dec. 13, William M'Farlane.
1837, Dec. 13, Dr. J. H. Robertson.
1837, Dec. 27, William Murray.
1837, Dec. 27, Thomas Watson.
1838, Dec. 5, Henry M'Donald.
1838, Feb. 7, James Murray.
1838, Feb. 7, James Smith, Deanston.
1838, Feb. 21, John Smith.
1838, March 21, John Black.
1838, March 21, Alexander Graham.
1838, April 18, Andrew M'Clure.
1838, Dec. 5, George Lancaster.
1839, Jan. 2, Patrick Adair Black.
1839, March 13, James Thomson.
1839, March 27, William Wilson.
1839, Nov. 6, John M'Bride.
1839, Nov. 6, William M'Bride.
1839, Nov. 20, Frederick Penny.
1839, Dec. 18, Alexander G. Edington.
1840, Jan. 8, George Robb, Saltcoats.
1840, Jan. 8, Alexander Wingate.
1840, Jan. 22, William Gourlie, jun.
1840, Feb. 5, James Dunlop.
1840, Feb. 19, Dr. John Findlay.
1840, Feb. 29, Frederick Adamson, jun.
1840, April 15, Matthew P. Bell.
1840, April 29, W. M. Buchanan.
1840, Dec. 2, William Cockey.
1840, Dec. 2, Professor L. D. B. Gordon.
1841, Jan. 27, J. Wilson, Auchineaden.
1841, Nov. 17, Dr. Andrew Anderson.
1841, Nov. 17, Matthew Adam.
1841, Nov. 17, Professor J. H. Balfour, M.D.
1841, Nov. 17, Walter G. Blackie, Ph.D.
1841, Nov. 17, John Cochran.
1841, Nov. 17, Charles Glassford.
1841, Nov. 17, William King.
1841, Nov. 17, Archibald Walker.
1841, Nov. 17, Dr. And. Kerr Young.
1841, Dec. 1, William More.
1841, Dec. 1, William Ramsay.
1841, Dec. 1, James F. Stewart.
1841, Dec. 1, T. Stenhouse, Crossmill.
1841, Dec. 1, Dr. Robert D. Thomson.
1841, Dec. 1, James Thomson, jun.
1841, Dec. 15, John Clugston.
1841, Dec. 15, Dr. J. G. Fleming.
1841, Dec. 15, Thomas Lindsay.
1841, Dec. 15, William Low.
1841, Dec. 15, George Rich.
1841, Dec. 29, Gilbert Weir.
1842, Jan. 12, John Alston.
1842, Jan. 26, George Thorburn, jun.
1842, March 8, Charles T. Dunlop.
1842, March 24, John Campbell.
1842, April 6, Wm. Hutcheson, M.D.

3d November, 1841,—DR. THOMAS THOMSON, *President, in the Chair*

THE Librarian reported the state of the Library funds, and presented a list of the Scientific Periodicals, proposed to be ordered for, the ensuing year; consisting of 11 English and American, 8 Fren and 5 German works.

The Vice-President having taken the Chair, the following communication was read:—

I. *On the Oxides of Bismuth.* By THOMAS THOMSON, M.D., F.R.S., &c., *Regius Professor of Chemistry, University of Glasgow.*

BISMUTH is rather a rare metal; but in consequence of the lowness of its melting point, and the few purposes to which it is applied, it sells at a comparatively small price. It occurs in nature almost always in the metallic state; and most of the bismuth of commerce comes from Saxony, where it is found mixed with the ores of cobalt. It is obtained by simply exposing these ores to heat in a crucible,—the bismuth melts at a low heat, and is collected at the bottom of the crucible. Bismuth as it occurs in commerce, is a somewhat brittle metal, having a reddish white colour, and is composed of broad plates adhering to each other.

It is not quite pure, for it contains iron, arsenic, sulphur, copper, and nickel, and probably other foreign bodies, though not in any considerable quantity. But it is easy to obtain it pure by the following process:—

Dissolve it in nitric acid, taking care that the excess of acid is not too great. Pour the solution into a large quantity of pure water. A fine white precipitate falls in scales, having a pearly or satiny lustre. This precipitate is a nitrate of bismuth. It must be collected on a filter, and washed with water; but we must not persist in washing it too long, because it is slightly soluble in water. Allow it to dry, and then expose it to an incipient red heat, in a platinum or porcelain crucible. The nitric acid is expelled, and an oxide of bismuth remains, having a deep orange colour while hot, but assuming a fine yellow colour on cooling. It is a pure oxide of bismuth. To reduce this oxide to metallic bismuth, we have only to put it into a bulb, blown in a green glass tube, and to pass through it a current of dry hydrogen gas, while the bulb is kept hot by means of a spirit lamp. If the heat be properly regulated, the reduced bismuth remains in the state of powder, or rather of small grains about the size of gunpowder, and may be easily taken out of the bulb. It was bismuth purified in this manner, that I employed in the following experiments:—

1. 13·5 grains of metallic bismuth, were put into a platinum

crucible and cautiously dissolved in dilute but pure nitric acid; taking care that while the solution was going on, the crucible was covered with a lid. The liquid portion was now driven out of the crucible by a low heat, and the crucible was kept for some time in a state of incipient incandescence. By this process the 13·5 grains of metallic bismuth were converted into yellow oxide. The amount of yellow oxide in different trials was 14·9, 15·1, 15·05 grains. Hence it follows that yellow oxide of bismuth is composed of

Bismuth, 13·5
Oxygen, 1·5 or 1½ atoms

15

and that its atomic weight is 15. I actually obtained

Bismuth, 13·5
Oxygen, 1·5016

Now 0·0016 grains, being far within the limits of the errors to which such an experiment is liable, ought I conceive to be neglected.

If 13·5 be the atomic weight of bismuth, then the yellow oxide is a compound of 1 atom bismuth, and 1½ atom oxygen.

The composition of yellow oxide of bismuth thus deduced, agrees with the results which I formerly obtained. I found it composed of

Bismuth, 9
Oxygen, 1

10

For that reason I considered the atom of bismuth to weigh 9, and the yellow oxide to be 10. But the result of the experiments of Dulong and Petit, of Neuman and of Regnault, to determine the specific heat of bismuth, do not accord with this atomic weight when we test it by the law of Dulong and Petit. We must adopt the number 13·5. And if this be the true number, then the yellow oxide of bismuth is a compound of 1 atom bismuth, and 1½ atom oxygen.

2. When bismuth in the state of a fine powder is exposed for a long time to the air, or when it is kept melted in a heat under redness in an open vessel, it is converted into a dark brown powder, which constitutes an oxide containing less oxygen than the yellow oxide. When we attempt to dissolve it in nitric acid it effervesces and is converted into yellow oxide. I formed a quantity of this oxide by melting bismuth in a porcelain crucible and stirring it with an iron rod, till the metallic particles nearly disappeared. I then reduced it to a fine powder, and passed it through a hair sieve in order to separate the metallic particles from the oxydized portion.

20 grains of this oxide were dissolved in nitric acid, the solution was evaporated to dryness, and the residual salt exposed to incipient redness, till all the nitric acid was driven off. The weight of the yellow oxide thus obtained was 21·4 grains.

Now 21·4 grains of yellow oxide are composed of

Bismuth,	19·26
Oxygen,	2·14
	21·40

Hence the suboxide must have been composed of

Bismuth,	19·26 or	13·5
Oxygen,	0·74 or	0·51
	20·00	

There seems no reason to doubt from this analysis, that the suboxide of bismuth is a compound of

1 atom bismuth,	13·5
½ atom oxygen,	0·5
	14

and that its atomic weight is 14. Like other suboxides it does not seem capable of combining with acids. No doubt it is a compound of

2 atoms bismuth,	27
1 atom oxygen,	1
	28

3. There is another oxide of bismuth which was discovered by Bucholz and Brandes in the year 1818, while engaged in the analysis of a copper ore from Hungary.*

During the analysis they obtained a mixture of silver and oxide of bismuth, which they fused with caustic potash and digested in water. A yellow powder remained, which disengaged chlorine when treated with muriatic acid, and which by exposure to heat was converted (with a loss of weight) into yellow oxide. From these and other experiments, which it is needless to state, it is evident that the oxide of bismuth obtained by them, contained more oxygen than the yellow oxide of that metal; but the conclusion which they drew, that it contained 50 per cent. of oxygen, was so inconsistent with every thing known of the constitution of the yellow oxide, that nobody for several years thought of examining into the existence of this new oxide of bismuth.

Stromeyer repeated their experiment in 1832, and found that when the yellow oxide of bismuth is exposed to a moderate heat when mixed with potash, it becomes brown, and after being washed, a brown powder remains, which disengages chlorine when mixed with muriatic acid.† The greatest part of the yellow oxide, however, when thus treated remains unaltered.

* Schweigger's Journal, Bd. 22, p. 27.

† Poggendorff's Annalen, Bd. 26, p. 548, and Ann. de Chim. et de Phys., t. 51, p. 267.

But he hit upon another and much easier method of preparing peroxide of bismuth. When yellow oxide of bismuth is mixed with a solution of chlorite of soda, and boiled in a flask, it soon assumes a dark brown colour, like that of peroxide of lead. Chlorite of soda is obtained by dissolving bleaching powder in water, and precipitating the lime from the solution by carbonate of soda. The boiling must be continued for some time. And then the brown powder is collected on the filter, washed and dried. In this state it is almost black, but is still a mixture of yellow oxide and peroxide. Stromeyer purified it by washing it in cold nitric acid, diluted with nine times its weight of water. According to the analysis of Stromeyer, 12·12 of it when heated to about 660° become yellow oxide, and lose 0·59 of oxygen. Hence 15 grains of yellow oxide in order to become peroxide must combine with 0·767 of oxygen. Hence he concludes, that the oxide of bismuth is a compound of

1 atom yellow oxide bismuth,	15
$\frac{3}{4}$ atom oxygen,	0·75
	15·75

So that its atomic weight is 15·75, and it consists of

1 atom bismuth,	13·5
$2\frac{1}{4}$ atoms oxygen,	2·25
	15·75

These atomic proportions appeared so unusual that I thought them not likely to be correct. It would indicate a compound of 4 atoms bismuth, and 9 atoms oxygen, as the constitution of peroxide of bismuth, I therefore prepared a quantity of peroxide of bismuth, by boiling anhydrous yellow oxide in fine powder with liquid chlorite of soda in a flask. I allowed the boiling to continue for 24 hours.

The product was a dark brown powder, very heavy; but in colour similar to peroxide of lead. It was easy by the application of dilute nitric acid, to detect in it the presence of yellow oxide of bismuth. But I found some difficulty in separating this yellow oxide; muriatic acid was out of the question, as chlorine was evolved and the whole oxide speedily reduced to common chloride of bismuth. I tried nitric acid, which Stromeyer employed, but it effervesced with the peroxide, evolving oxygen, and before I could succeed in removing the yellow oxide almost the whole of the peroxide disappeared. Sulphuric and phosphoric acids did not answer better. They caused an effervescence with the evolution of oxygen, and the peroxide was gradually reduced to yellow oxide. I did not try sulphurous acid, thinking it not at all likely to answer. But Stromeyer says that it slowly changes the peroxide of bismuth into subsulphate. At last, after a great many fruitless trials, I found that dilute acetic acid might be digested upon it without any sensible action. It has the property of dissolving yellow oxide of bismuth. By repeated digestions in successive portions of distilled vinegar, I succeeded at last in separating the whole yellow oxide, and thus obtaining the peroxide in a state of purity.

It was in very small scales having a silvery lustre, and had a brown or rather a buff colour, not so dark as that of the original mixture of yellow and brown oxides. It was tasteless, heavy, insoluble in water, and acted on by acids in the way just stated. Neither the fixed alkalies nor ammonia have any sensible action on it.

To prepare it for analysis, I washed it with water till that liquid came off perfectly pure. I then dried it in the open air, and finally kept it in a temperature of 300° till it ceased to lose any weight. I then put it into a platinum crucible, and gradually heated it by a spirit lamp till it was converted into yellow oxide. Two successive experiments yielded exactly the same result. 19·8 grains of it lost, when thus treated, 2·1 grains of weight, and were converted into yellow oxide. So that peroxide of bismuth according to this result is composed of

Yellow oxide,	17·9 or	15
Oxygen,	1·9 or	1·59

This is very nearly one atom of yellow oxide and an atom and a half of oxygen. I have no doubt that the exact quantity of oxygen is 1·5 or an atom and a half. Thus we have the atomic weights and composition of the suboxide, the yellow and brown oxides of bismuth as follows:—

	Bismuth.		Oxygen.
Suboxide,	2 atoms,	+	1 atom.
Yellow Oxide,	1 —	+	1½ —
Peroxide,	1 —	+	3 —

The atom of bismuth must weigh 13·5.

I found the brown oxide of bismuth as originally prepared, by boiling yellow oxide in chlorite of soda, a compound of

12·25 yellow oxide.
2·75 brown oxide.

Or nearly 5 atoms yellow oxide, and 1 atom brown oxide.

It is obvious, from the results just stated, that Stromeyer had not succeeded in freeing his brown oxide from all admixture of yellow oxide.

The constitution of the oxides of bismuth would be simplified were we to double its atomic weight, and make it 27. Then the suboxide would be a compound of 1 atom bismuth and 1 atom oxygen, the yellow oxide of 1 atom bismuth and 3 atoms oxygen, and the brown oxide, a compound of 1 atom bismuth and 6 atoms oxygen. But the experiments made to determine the specific heat of bismuth, will not admit of any such increase. This specific heat is—

According to Neumann,	0·027
According to Dulong and Petit,	0·0288
According to Regnault,	0·03084
Mean,	0·02888

It was observed by Dulong and Petit that if the atomic weight of a body be multiplied by its specific heat, the product is a constant quantity. This has been confirmed by the subsequent experiments of Avogadro, of Neumann, and of Regnault, made expressly to put the statement to the test of experiment. I infer from it that every atom is surrounded by the same quantity of heat. The constant quantity obtained by multiplying the specific heats and atomic weights together, is (if we make use of the late experiments of Regnault, which are probably the most accurate,) 4. If therefore, we divide 4 by the atomic weight of bismuth, the quotient must give us the specific heat. Now, dividing 4 by 13·5 we obtain for a quotient 0·0296. This differs from the mean above stated, by 0·008, or less than 1 per cent, and from the determination of Regnault by 0·0012, or only 1½ per cent. Now, if we attend to the difficulties which experiments to determine the specific heat of bodies are liable to, we must feel rather surprised that the agreement is so very near, than that it should amount to so much as 1 per cent.

I conceive, therefore, that there can be no doubt that 13·5 is the true atomic weight of bismuth, and that yellow oxide of bismuth is a compound of two atoms bismuth, plus three atoms oxygen; and brown oxide of one atom bismuth and three atoms oxygen, or at least of some multiple of these numbers. It would be necessary to determine their specific heats in order to obtain absolute numbers.

17*th November*, 1841,—*The* PRESIDENT *in the Chair.*

The following gentlemen were admitted as members of the society:—John Hutton Balfour, M.D., Regius Professor of Botany, Andrew K. Young, M.D., Charles Glassford, Esq., John Cochrane, Esq., Walter G. Blackie, Ph. D., Andrew Anderson, M.D., Archibald Walker, Esq., Matthew Adam, Esq.., William King, Esq.

The accounts which had been previously audited were presented by the Treasurer and Librarian, exhibiting an expenditure of £64 8s. 11d. for books during two years, and a surplus in the hands of the Treasurer amounting to £75 8s. 5d.

The society then proceeded to the fortieth annual election of office-bearers.— (See page 2.)

1*st December*, 1841,—*The* PRESIDENT *in the Chair.*

THE following gentlemen were admitted members:—William Ramsay, Esq., James F. Stewart, Esq., R. D. Thomson, M.D., James Thomson, Esq., Jun., Thomas Stenhouse, Esq., William More, Esq.

The following communication was then read:—

II.—*On the Determination of the Melting Points of Metals and various Metallurgic Products, and of the Temperature required for the formation of different Silicates. By* LEWIS D. B. GORDON, Esq., *Regius Professor of Civil Engineering and Mechanics, University of Glasgow.*

IN reviewing the state of our knowledge of the melting points of bodies, seven different classes of pyrometers that have been employed or proposed by experimenters were briefly mentioned, and it appeared that the many researches undertaken by philosophers with those instruments afford us only a *graduated scale of the fusibility* of the substances tried, and do not give *the absolute melting* points, save for a certain number of metals in their simple state.

Table No. I. gives the results of different experimenters, from which it appears how little, on the whole, had been done in this important subject until Plattner of Freyberg undertook a most elaborate series of experiments, of which, and of their results, it is the object of this paper to give some account.

Plattner was guided in his course of research by the methods of Prinsep and Daniell, but more especially by the method of de Saussure, for determining the melting points.

Saussure's method consisted in endeavouring to determine the fusing point of a substance in degrees of Wedgewood's pyrometer, according to the diameter of the greatest assay he could fuse before the blowpipe, by comparison with the diameter of the greatest globule of silver he could melt under circumstances in every respect the same, and the melting point of which he knew.

[The instruments employed, and method of experimenting adopted by Plattner for perfecting this notion of de Saussure, were exhibited and explained.]

For determining the melting points of the more easily fusible products, alloys of gold and silver, and silver and lead, (see Table II,) were employed; and for those of the more refractory products, alloys of *gold and platinum* were used.

The determination of the melting point of *platinum* was a preliminary step, and this was ascertained by two experiments, as follows:—

1°. It was found that with a blowpipe supplied with air, under a gentle pressure, from a gasometer, a gold regulus weighing 2290 *milligrammes,* can be fused and maintained in fusion on charcoal, and in the same circumstances, an alloy of 1760 mill. gold + 230 mill. platinum can be maintained in fusion; and if either more gold, or a very small quantity of platinum, be added, the fusion is imperfect.

2°. An alloy of gold and platinum was found having the same melting point as *cast iron*, viz., 70 gold + 30 platinum fused in the same time as 100, by weight, of cast iron.

The melting point of platinum is deduced from these experiments to be—

$$\left.\begin{array}{r}\text{From } 1^\circ\ 2529^\circ\ \text{C.}\\ 2^\circ\ 2539^\circ\ \text{C.}\end{array}\right\}\text{Mean, } 2534^\circ\ \text{C.}$$

and these experiments appeared satisfactorily to warrant the assumption that *alloys of silver and gold,* and *gold and platinum, have melting points proportional to the melting points of each of these metals;* an assumption made by Prinsep.

Mitscherlich's determination of 1560° C. as the melting point of platinum was referred to, but as this involves all previous determinations of the melting points of other metals being erroneous, that is, much too high, Plattner was justified in assuming his own determination as the basis of the temperatures given in Table II. and in his further researches.

The melting points of	Lead being taken at		334° C.
	Silver,	—	1023° C.
	Gold,	—	1102° C.
	Platinum,	—	2534° C.

it was easy, according to the method described, to determine the melting points of the most refractory substances, so long as these were under that of platinum. The alloy being found having the same melting point as that of the body under research, its value was then

$$x = \frac{\text{A s} + \text{B s}'}{100}$$

Where A and B are the weights, and s and s′ the melting points of the metals contained in the alloys. And 100 parts by weight of alloy, and body under experiment, were taken respectively.

Attention was called to the circumstance that Daniell had fixed the melting point of copper at 1091° C., or under that of gold. Prinsep found, from constant experience as an assayer, that this is not the case, and fixed the melting point to be the same as that of an alloy of 97 parts gold and 3 parts platinum. Plattner found 95 parts gold and 5 platinum to answer more exactly, and hence, applying the above formula,

$$x = \frac{95 \times 1102^\circ + 5 \times 2534^\circ}{100} = 1173^\circ$$

the melting point of copper.

The second part of Plattner's researches *on the Determination of the*

Temperature necessary for the Formation of different Silicates, was promised, should the society consider it of sufficient interest, as the subject of a future communication.

TABLE I.

TABULAR VIEW OF THE MELTING POINTS OF METALS, AS DETERMINED BY DIFFERENT EXPERIMENTERS.

Tin melts at	228°	Centigrade, according to		Crichton.
Do. do.	267°	......	......	Guyton.
Do. do.	228°	......	......	Rudberg.
Do. do.	230°	......	......	Kupffer.
Do. do.	222·5°	......	......	Ehrmann.
Bismuth do.	246°	......	......	Crichton.
Do. do.	241°	......	......	Guyton.
Do. do.	265°	......	......	Rudberg.
Do. do.	264°	......	......	Ehrmann.
Lead do.	322¼°	......	......	Crichton.
Do. do.	322·2°	......	......	Guyton.
Do. do.	325°	......	......	Rudberg.
Do. do.	334°	......	......	Kupffer.
Quicksilver boils at . . .	350°	Centigrade, according to		Dulong and Petit.
Zinc hardens *above* . . .	400°	......	......	Rudberg.
Do. melts at	411°	......	......	Daniell, measured with an *Iron Rod.*
Antimony do.	512°	......	......	Guyton.
Silver melts at	1023°	......	......	Daniell, measured with *Iron Rod.*
Do. do.	1034°	......	......	Guyton.
Do. do.	999°	......	......	Prinsep.
9 parts silver 1 part gold do.	1048°	......	......	do.
3 do. 1 do. do.	1121°	......	......	do.
Copper 1132° C. corrected to	1091°	......	......	Daniell, with Platinum rod.
Do. melts at	1207°	......	.....	Guyton.
Do. do.	1173°	......	......	Plattner.
Gold, 1144° corrected to .	1102°	......	......	Daniell.
Do. melts at	1163°	......	......	Do. with *Iron Rod.*
Do. do.	1380°	......	......	Guyton.
Cast Iron, 1587° corrected to	1530°	......	......	Daniell, with Platinum rod.
Platinum melts at . . .	2534°	......	......	Plattner.

TABLE II.

MELTING POINTS OF VARIOUS METALLURGIC PRODUCTS.

Name of the substance, the melting point of which is determined.	100 by weight of this substance melt in the same temperature and in the same time to a globule as alloys of				Melting point, deduced by calculation.
1. Sulphuretted metals, from process termed *Roharbeit,*	30 Gold,	+	70 Silver,	=	1047°C.
2. Do. Lead process, ...	5 —	+	95 —	=	1027°
3. Do. Copper do., ...	3 Lead,	+	97 —	=	1002°
4. Aseniuretted Metals,—Lead, ...	50 Gold,	+	50 —	=	1062°
5. Raw Copper, ...	5 —	+	95 —	=	1027°
6. Red Litharge, ...	90 Silver,	+	10 Lead,	=	954°
7. Slags:—					
a. Greenish yellow colour, and slight glass vitreous lustre, ...	84 Gold,	+	16 Platinum,	=	1331°

TABLE II.—MELTING POINTS OF VARIOUS METALLURGIC PRODUCTS, *Continued.*

Name of the substance, the melting point of which is determined.	100 by weight of this substance melt in the same temperature and in the same time to a globule as alloys of					Melting point deduced by calculation.
b. Dark grey, slight vitreous lustre, . .	82	—	+ 18	—	=	1360°
c. Light grey colour, slight vitreous lustre, (Hot blast,)	83	—	+ 17	—	=	1345°
d. Dark grey vitreous lustre, slight, (Hot blast,)	82	—	+ 18	—	=	1360°
e. Dark grey, vitreous lustre, ...	83	—	+ 17	—	=	1345°
f. Grey and blue striped, and vitreous fracture, ...	84	—	+ 16	—	=	1331°
g. Dark grey, slight vitreous lustre, . .	83	—	+ 17	—	=	1345°
h. Same, Hot blast, ...	83	—	+ 17	—	=	1345°
Copper Slags, Raw Metal, ...	83	—	+ 17	—	=	1345°
Tin Slags, Pure, ... Block, vitreous lustre, ...	85	—	+ 15	—	=	1317°
Iron Slag, Blast furnace, going on No. 4 Iron, Slags, greenish coloured vitreous fracture,	80	—	+ 20	—	=	1388°
Iron Slag, Puddling, Iron, black colour, metallic lustre, slight, .	77	—	+ 23	—	=	1431°

15*th December,* 1841,—*The* PRESIDENT *in the Chair.*

THE following members were admitted:—Thomas Lindsay, Esq., William Lowe, Esq., J. G. Fleming, M.D., John Clugston, Esq., George Rich, Esq.

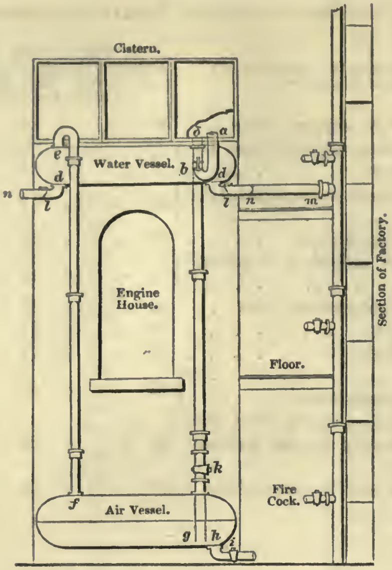
The following communications were read:—

III. *On the Means of Extinguishing Fires in Factories.* *By* D. MACKAIN, M.I.C.E.

THE extensive fires that have lately occurred in two of the largest factories in this city have had their origin in the upper floors of the buildings. In one case, the fire began while the people were at work, and when the command of a very small quantity of water would have been sufficient to have extinguished it. In the other case, the fire began at night.

As the greater number of factories have cisterns of considerable capacity placed above the engine house, and at a height of about thirty feet from the ground, they could easily, and at a small cost provide themselves with the means of extinguishing fire in any part of their buildings, by adopting a modification of the apparatus most commonly known by the name of the Chemnitz, or Hungarian Machine. A sketch of the proposed mode of applying this apparatus is here given.

Below the cistern of the engine house, let there be placed an upper receiver, or, as it is termed in the sketch, *a water vessel,* formed of boiler plates. A pipe, *a, b,* having a curved end fitted with a valve, *b,* communicates between the cistern and the water vessel.



From the bottom of the water vessel, conduit-pipes may be carried and connected with others leading into the second floors of the factory below, and above the water vessel, to a height nearly equal to the distance between the water vessel and the air vessel yet to be described; and from these pipes, others fitted with fire-cocks may ramify through the entire extent of the buildings.

Nearly on a level with the ground is placed another receiver, marked in the sketch as the ***air vessel,*** and formed of the same materials as the water vessel, but of double its capacity. A pipe, δ, *g*, fitted with a stop-cock, *k*, leads from the bottom of the cistern to nearly the bottom of the air vessel.

Another pipe, *h*, also fitted with a stop-cock, *i*, is attached to the bottom of the air-vessel, for emptying it, after it has been filled with water. An air-pipe, *f*, *e*, is conducted from the top of the air-vessel, to the top of the water vessel, to which it descends with a curve, after having been carried to the height of the top of the cistern.

The apparatus being thus arranged, the presence of water in the cistern will raise the valve, *b*, on the curved pipe of the water vessel, and flow into it; and the lower cock, *i*, of the air vessel being opened, the air contained in the water vessel will be discharged by the air pipe, and the vessel will be entirely filled with water. If the cock, *i*, be shut, and the cock, *k*, be opened, the water will flow from the cistern into the air vessel, compressing the air in it, and in the air pipe, *f*, *e*, with the force due to the height of the column of water in the pipe. The compressed air will thus act, through the air pipe, on the surface of the water in the water vessel, and the valve, *b*, being thereby shut, the water will be forced along the pipes, *m*, *n*, to the same height above the water vessel, as the distance between the surfaces of water in the cistern and air vessel.

Thus, if the air vessel be at the level of the ground,—the surface of water in the cistern be 30 feet above it,—and the water in the water vessel, 25 feet above the ground,—water will flow from the conduit-pipes at the height of 55 feet above the ground; and the pipes might be made to discharge any required volume, in a given time, below this point, by a proper adjustment of the diameters of the pipes, and of the difference between the several water surfaces. The velocity of discharge *below* the cistern, is that due to the extreme height to which the compressed air can raise the water in the upright pipe.

When the upper vessel is exhausted, the stop-cock, *k*, on the pipes leading from the cistern, is to be shut; the stop-cock, *i*, for discharging water from the air vessel, is to be opened; and the pressure being now taken off the water vessel, the valve, *b*, on the feeding pipe, will be opened by the water in the cistern; the water vessel will be charged, and the apparatus be again ready for use.

I understand that this machine is so arranged in Hungary that it is self-acting. It, therefore, would only require a stop-cock on the conduit-pipes, to be opened or to draw water in the event of fire, to set it in motion,—an instantaneous aid that, in such cases, is invaluable.

The greater size of the lower vessel is necessary to admit of the compression of the air to the requisite extent, and at the same time that there shall remain a bulk of compressed air equal to the contents of the water vessel, so as to expel the volume of water with which it was filled.

As air compresses into one half of its bulk, with a weight equal to that of the atmosphere, or of a column of water 33 feet in height, it follows, that by this apparatus only one half of the quantity of water which falls from the cistern into the lower air vessel, can be raised to the height of 33 feet above the water vessel, or 66 feet above the ground; and following out the law of compression, only one fourth of the quantity could be raised to 99 feet above it, or to 130 feet above the ground.

These are heights not usually coming within the scope of ordinary cases, in the circumstances now in view; but the pressures due to these heights can be produced by multiplying the number of cylinders on the same levels, and thus forces of great intensity, though of moderate ranges of extent, could be obtained by this apparatus, and rendered available for many purposes connected with manufactures and the arts.

(MR. MACKAIN exhibited a model of this apparatus, in which the receivers were 4½ feet apart, and a flow of water was produced from pipes connected with the water vessel, at the same height. A second pair of receivers were connected; and the pressure, amounting to double of the first pair, was exhibited by a column of mercury.)

IV.—*On the Cultivation of Plants in Close Cases.* *By* William Gourlie, Jun., Esq.

An Account was given of the observations which led Mr. N. B. Ward to the discovery of his mode of growing delicate exotic plants in the centre of large towns, or during lengthened voyages; but as these are fully detailed in a work on this subject lately published by him, they need not be repeated here.

Mr. Ward's experiments were conducted in "closed cases" of all sizes and shapes, from small wide-mouthed bottles to a range of houses about twenty-five feet long and ten feet high. Some of them are quite closed at the bottom, and when once watered require no further waterings for a long period, while others have several openings, and are watered once in three or four weeks or months, as may be required. The glazed roofs and sides of these cases are made to fit as tight as putty and paint can effect, and the doors fit closely; but in no instance has Mr. Ward endeavoured to seal his cases hermetically, believing that the success of the plan is partly owing to the very gradual change of air which takes place by the alternate expansion and contraction of the volume enclosed.

[A small glazed case, constructed like Mr. Ward's, and containing twelve species of exotic plants, was exhibited; it was nearly air tight, and the moisture which evaporated being condensed upon the glass, trickled back into the mould in the bottom of the case.]

Plants enclosed in these cases can bear greater extremes of heat and cold than when unprotected, which Mr. Ward thinks is owing to the perfectly quiet state of the atmosphere surrounding them. They are thus admirably calculated for conveying living plants from foreign countries, and this has already been done to a great extent, many new and rare species having arrived in almost perfect health.

Owing to the prevention of the escape of the moisture within the cases, plants will grow in them for many months, or even years, without requiring fresh supplies of water; for the supply of water given to the soil in the first instance is successfully absorbed, exhaled, and condensed within the case itself, and made to sustain, over and over again, the vegetation of the same plants.

The plants are protected from the deleterious effects of poisonous gases and fuliginous matter, generated by the combustion of coal. We need not recount the experiments which have been made to prove the fatal effects of such gases as sulphurous acid, sulphuretted hydrogen, or muriatic acid, upon plants, as their action upon the vegetation around Glasgow must be obvious to every observant person, but merely state, that from such a vitiated atmosphere as exists in large cities, the plan of Mr. Ward provides effectual protection, which the success of his own establishment, situated in Wellclose Square, London, amply demonstrates.

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PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTIETH SESSION, 1841-42.

CONTENTS.

29th December, 1841,—*The* PRESIDENT *in the Chair.*

Mr. Gilbert Weir was admitted a member.

At the request of Mr. Liddell, the Physiological section were instructed to collect information respecting the best means of preparing cheap and nutritious food. Mr. Liddell stated that the managers of the Night Asylum for the Houseless, and of similar institutions would probably receive considerable benefit from a report embodying this information.

The following communications were read:—

V.—*On Digestion.* By DR. JOHN FINDLAY.

[The absence of the Author, who is at present on the Continent, renders it impossible to give an abstract of this Memoir.]

VI.—*On Chlorimetry, and on a new mode of Testing weak Solutions of Bleaching Powder.* By WALTER CRUM, Esq.

CHLORIDE OF LIME is one of those substances whose value cannot be judged of from its external appearance, and which is always mixed with a certain quantity of foreign matter. An experiment is therefore necessary to test it, and an easy method of performing such an experiment has always been a desideratum with those who manufacture or employ it.

I propose to give an account of some of the methods which have been hitherto in use for ascertaining the strength of mixtures containing chlorine, and then to describe one I have myself employed for some time.

The oldest method is that of Decroizilles, where the amount of chlorine in a solution is measured by the quantity of indigo which that solution is capable of discolouring. Welter made use of it, in his researches on the nature of chloride of lime, in 1818, and considered it susceptible of great accuracy, by attending to certain precautions which he pointed out. In 1824, Gay Lussac published a set of experiments on this art, to which he gave the name of Chlorimetry. He also adopted the indigo test, and made every arrangement for accuracy which the method would permit. A volume of chlorine was taken for unity; or, which is the same thing, a volume of liquid which had absorbed its bulk of chlorine. This is formed by filling a bottle with chlorine gas, inverting it in a vessel containing cream of lime, and withdrawing the stopper. The chlorine is gradually absorbed, and its place taken by the lime water,—which has then become a solution of bleaching powder containing its own volume of chlorine gas.

To form the indigo solution, one part of the best indigo of commerce is dissolved in nine of sulphuric acid, and diluted with water to such an extent, that one measure of the chlorine solution discolours ten measures of it. When the two solutions are mixed together, the chlorine is set free by the sulphuric acid in which the indigo is dissolved, and the indigo is immediately destroyed. The solution of indigo is called "proof tincture," and the quantity of it, which an unknown solution of bleaching powder is capable of discolouring, indicates the bulk of chlorine gas which it contains.

Much of the accuracy of this method depends upon the way in which the two solutions are mixed. Thus, by pouring the chlorine slowly upon the indigo, much more of it is destroyed than when the indigo solution is poured into that containing the chlorine. A great many trials satisfied M. Gay Lussac, that the best process is to mix the two solutions rapidly together. But then several preliminary trials are necessary to ascertain pretty nearly how much should be employed.

Three years after, in 1827, M. Morin, of Geneva, published experiments on chloride of lime, and discussed the merits of the indigo test. He found it impossible to have the circumstances always so much alike as to produce any thing like uniform results with it. In 1831, M. Marozeau corroborated the view taken by Morin, and added, (what every one who has repeated the process must have noticed,) that it is very difficult to observe the exact point at which the indigo is wholly destroyed, from the want of a distinct line between the brown after complete discoloration, and the slightly greenish tint, which M. Gay Lussac indicates as the point most desirable to stop at.

Each of these chemists proposes a substitute for the chlorimeter of Gay Lussac. M. Morin would employ muriate of manganese instead of indigo, but he gives no details of his process, and it would seem to be both tedious and uncertain. The process of M. Marozeau is founded on the property which chlorine possesses of converting calomel, an insoluble substance, into corrosive sublimate, which is abundantly soluble, and which contains twice as much chlorine. Protonitrate of mercury is formed by boiling nitric acid and water with an excess of mercury. It is afterwards diluted and set aside, when subnitrate precipitates. The salt remaining in solution, after being made of a strength to correspond with a volume of dry chlorine gas, is the proof liquor. To ascertain by this means the strength of any solution containing chlorine, we take a measure of nitrate of mercury, add muriatic acid to convert it into calomel, and then the chloride slowly. The quantity necessary to make the precipitate entirely re-dissolve is inversely as the chlorine which it contains.

At last, M. Gay Lussac himself, in the year 1835, announced that, after three years experience of a new process, he had abandoned the method with indigo. His objections to it are partly those already stated, and partly the change which readily takes place on the indigo solution when preserved for any length of time. By the new method, any one of three substances may be employed with the same apparatus, and with nearly equal advantage—

1. Arsenious acid.
2. Ferrocyanide of potassium.
3. Protonitrate of mercury.

M. Gay Lussac prefers, however, the arsenious acid, from the precision of its indications. He retains the same basis of measurement as for the test with indigo alone; that is, he takes for unity the discolouring power of one volume of chlorine dissolved in an equal volume of water. That is divided into 100 equal parts. The arsenious solution is prepared of a strength just sufficient to destroy an equal volume of chlorine gas, or of the chlorine solution. If we take a constant quantity of the unknown solution of chlorine, say 10 cubic centimeters, and pour into it the arsenious solution till the chlorine is gone, the force of the chlorine solution will be in proportion to the quantity of arsenic employed. If the 100 measures of solution of chloride have taken 100 measures of the arsenious solution, then it has the strength of 100, and it contains its own volume of chlorine gas. If only 80, then it is called of the strength of 80 degrees, and it contains $\frac{80}{100}$ of its bulk of chlorine gas. But this mode of operating would not give good results, for the muriatic acid which is employed to dissolve the arsenic, and without which the action of the chlorine would be incomplete, disengages the chlorine from its fixed combination with lime faster than it has arsenic to act upon, and thus a portion escapes into the air. The solution of bleaching powder must therefore be poured by degrees into the arsenious solution, and as the strength of the chlorine solution is then inversely as the quantity employed, a calculation is necessary, or a table has previously to be prepared, by the inspection of which, the result may at once be observed. The point of saturation of the arsenic is indicated by a blue tinge, which is given to the arsenious solution by indigo. This substance is not affected by chlorine so long as any arsenious acid is left, after which a single drop of chlorine solution causes it to disappear.

In employing the prussiate of potash, the instruments and manipulation are the same. Its solution is made of the same strength as the arsenious solution, that is, that it should saturate an equal volume of the normal solution of chlorine. Prussiate of potash has a very slight action upon chloride of lime, but if previously rendered acid, it is immediately changed by it, and becomes yellow.

The prussic acid test has long been employed by my friend, Mr. John Mercer of Oakenshaw, near Manchester. His test, to mark the point at which the prussic acid becomes saturated, is the red oxide of iron. A bit of calico dyed buff with iron, is touched with the solution after each addition of the chlorine, and as soon as it ceases to become blue, enough of the chlorine has been added.

Gay Lussac's third process is that of M. Marozeau with nitrate of mercury already described. It appears that Balland de Toul first recommended this method, two years before the publication of M. Marozeau.

Mr. John Dalton pointed out a process in 1813, which gives very good results; and, arranged as it has been by Mr. Graham, it seems to be the best and most easily executed of all the tests of bleaching powder. Mr. Graham directs that a few ounces of good crystals of protosulphate of iron should be pounded, and dried between folds of cloth. 78 grains of crystals so dried, are equivalent to 10 grains of chlorine. The 78 grains are to be dissolved in 2 ounces of water, and acidulated with a few drops of muriatic acid. 50 grains of the bleaching powder to be examined, are dissolved in about 2 ounces of tepid water, by rubbing them together in a mortar. The whole is then poured into a graduated tube, called an alkalimeter, divided into 100 parts, and filled up with water to 0 on the scale. The solution of bleaching powder being thus made up to 100 measures, is poured into the solution of iron until it is wholly saturated. The point of saturation is discovered by means of red prussiate of potash, which gives a blue precipitate with protoxide of iron only, and not with salts of the peroxide. A white stoneware plate is spotted over with small drops of the red prussiate; and, as soon as the iron solution ceases to produce a blue, when a drop of it is applied to one of these spots, no more protosulphate remains. Suppose 72 measures of the bleaching liquor to have saturated the 78 grains of green copperas, then these 72 measures contained 10 grains of chlorine, which is equal to 13·89 grains in the 50 grains of chloride of lime, or 27·78 grains of chlorine in 100 grains. The calculation is simplified by at once dividing 2000 by the number of measures required, thus:—

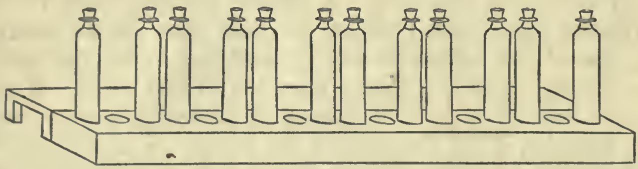
$$\frac{2000}{72} = 27{\cdot}78.$$

On repeating the experiment in the way prescribed by Mr. Graham, I find it of importance to mix the two solutions in a phial. It is corked up and well shaken after each addition of the bleaching liquid. By this means the chlorine, a small quantity of which is set free after every addition, is prevented from escaping, and a much more perfect agitation and mixture is attained than by the use of the spatula. By the same means the employment of the mortar and alkalimeter may be dispensed with. If the 78 grains of the sulphate of iron be put, along with some muriatic acid, into a wide-mouthed 4 oz. phial, half filled with water, the bleaching powder may be added dry, and the result obtained by weighing the residue.

Chlorimetry requires to be practised by the bleacher for two purposes —First, he has to learn the commercial value of the bleaching powder which he purchases; and with that view he can scarcely desire any thing better than the method either by arsenious acid, or green copperas. But the more important, because the hourly testing of his bleaching liquor, and that on which the safety of his goods depends, is the ascertaining the strength of the weak solutions in which the goods have to be immersed. If the solution is too strong, the fabric is apt to be injured. If too weak, parts of the goods remain brown, and the operation must be repeated. The range within which cotton is safe in this process is not very wide. A solution standing 1° on Twaddell's hydrometer, (spec. grav. 1.005) is not more than safe for such goods, while that of half a degree is scarcely sufficient for the first operation of stout cloth, unless it is packed more loosely than usual. When the vessel is first set with fresh solution of bleaching powder, there is little difficulty, if the character of the powder be known; but when the goods are retired from the steeping vessels, they leave a portion of bleaching liquor behind, unexhausted, which must be taken into account in restoring the liquor to the requisite strength for the next parcel. The chlorimeter must, therefore, be applied every time that fresh goods are put into the liquid. It must consequently be intrusted to persons who may not be expert either in figures or in chemical manipulation. Hence all the processes I have described are too delicate and tedious.

I introduced another into our establishment some years ago, which has been in regular use ever since, and by which the testing is performed in an instant. It depends on the depth of colour of the peracetate of iron. A solution is formed of proto-chloride of iron, by dissolving cast-iron turnings in muriatic acid, of half the usual strength. To ensure perfect saturation, a large excess of iron is kept for some time in contact with the solution at the heat of boiling water. One measure of this solution, at 40° Twaddell, (spec. grav. 1.200) is mixed with one of acetic acid, such as Turnbull and Co. of Glasgow sell at 8s. a gallon. That forms the proof solution. If mixed with six or eight parts of water it is quite colourless, but chloride of lime occasions with it the production of peracetate of iron, which has a peculiarly intense red colour.

A set of phials is procured, 12 in number, all of the same diameter. A quantity of the proof solution, equal to $\frac{1}{9}$th of their capacity, is put into each, and then they are filled up with bleaching liquor of various strengths, the first at $\frac{1}{12}$th of a degree of Twaddell, the second, $\frac{2}{12}$ths, the third, $\frac{3}{12}$ths, and so on up to $\frac{12}{12}$ths, or 1 degree. They are then well corked up, and ranged together, two and two, in a piece of wood, in holes drilled to suit them. We have thus a series of phials, showing the shades of colour which those various solutions are capable of producing. To ascertain the strength of an unknown and partially exhausted bleaching liquor, the proof solution of iron is put into a phial similar to those in the instrument, up to a certain mark, $\frac{1}{9}$th of the whole. The phial is then filled up with the unknown bleaching liquor, shaken, and placed beside that one in the instrument, which most resembles it. The number of that phial is its strength in 12ths of a degree of the hydrometer; and, by inspecting the annexed table, we find at once how much of a solution of bleaching powder, which is always kept in stock, at a uniform strength of 6 degrees, is necessary to raise the whole of the liquor in the steeping vessel to the desired strength.



The instrument is formed of long 2 ounce phials cast in a mould; those of blown glass not being of uniform diameter. The outside, which alone is rough, is polished by grinding, and in this state they can easily be procured at 4s. 6d. a dozen. They are placed two and two, so that the bottle containing the liquid to be examined may be set by the side of any one in the series, and the colour compared by looking through the liquid upon a broad piece of white paper stretched upon a board behind the instrument.

To explain the table it is necessary to state that the steeping vessels we employ contain, at the proper height for receiving goods, 1440 gallons, or 288 measures of 5 gallons each,—a measure being the quantity easily carried at a time. In the following table, 0 represents water, and the numbers 1, 2, 3, &c., are the strength of the liquor already in the vessel in 12ths of a degree of Twaddell, as ascertained by the chlorimeter. If the vessel has to be set anew, we see by the first table that 32 measures of liquor at 6° must be added to (256 measures of) water to produce 288 measures of liquor at $\frac{8}{12}$ths of a degree. But if the liquor already in the vessel is found by the chlorimeter to produce a colour equal to the 2d phial, then 24 measures only are necessary, and so on.

To stand $\frac{8}{12}$°				To stand $\frac{6}{12}$°			
0	requires	32	measures.	0	requires	24	measures.
1	—	28	—	1	—	20	—
2	—	24	—	2	—	16	—
3	—	20	—	3	—	12	—
4	—	16	—	4	—	8	—
5	—	12	—	5	—	4	—
6	—	8	—				
7	—	4	—				

To stand $\frac{4}{12}$°				To stand $\frac{3}{12}$°			
0	requires	16	measures.	0	requires	12	measures.
1	—	12	—	1	—	8	—
2	—	8	—	2	—	4	—
3	—	4	—				

Let us see what takes place on mixing chloride of lime with protomuriate of iron. On the old view of the constitution of bleaching powder—that it is a combination of chlorine and lime, we have

$$\left.\begin{array}{l} 3\,(CaO,\,Cl) \\ 6\ \ FeCl \end{array}\right\}\text{ becoming }\left\{\begin{array}{l} 3\ CaCl \\ 2\ Fe_2Cl_3 \\ \ \ \ Fe_2O_3 \end{array}\right.$$

the peroxide of iron forming peracetate with the acetic acid which is present. Or, supposing with Balard that when two atoms of chlorine unite with two atoms of lime, the product is $CaCl + CaO, ClO$, we have this formula:

$$\left.\begin{array}{l} 3\ \ CaCl \\ 3\ (CaO,\,ClO) \\ 12\ \ FeCl \end{array}\right\}\text{ becoming }\left\{\begin{array}{l} 6\ CaCl \\ 4\ Fe_2Cl_3 \\ 2\ Fe_2O_3 \end{array}\right.$$

Here one third only of the iron goes to form the deep coloured peracetate, while the whole might be employed for that purpose, by using protoacetate instead of protochloride. The latter however is preferred, from the greater tendency of the acetate to attract oxygen from the air, and consequently the greater difficulty of preserving it. Even with the chloride it is best to give out small quantities at a time, preserving the stock in well closed bottles.

[Mr. Crum exhibited Dr. Clark's patent process for purifying water from bicarbonate of lime.]

12th January, 1842,—*The* PRESIDENT *in the Chair.*

John Alston, Esq. of Rosemount admitted a member. A communication was read by JAS. THOMSON, ESQ. JUN., *On an Improvement in the Motive Power of River Navigation.*

26th January, 1842,—MR. GRIFFIN *in the Chair.*

George Thorburn, Esq., Jun., admitted a Member. The following communications were then read.

VII.—*On the Ventilation of the Glasgow Fever Hospital. By* D. MACKAIN, ESQ., *Civil Engineer.*

MR. MACKAIN had visited the Glasgow Fever Hospital at the request of the Medical Committee, with the view of examining the means of ventilation which had previously been in use, and which were considered to be insufficient. On examination, he was of opinion that this insufficiency proceeded, in a great measure, from the relative positions of the apertures by which warm air was introduced into the wards, and those by which it was designed that the vitiated air should be withdrawn; the former being in the corners of the wards, near to the floor; the latter nearer to the centre of the room, at the ceiling, but in the same partition with the former.

The result of this arrangement was, that the heated air, on entering the wards, rose towards the aperture of escape in a continuous stream, without mixing with the air in the ward, or communicating its heat.

As there were no other arrangements for furnishing a supply of fresh air during cold weather, beyond the partial opening of the windows, it appeared probable that the change of position of the mass of air in some parts of the wards, was occasioned solely by the levity of such portions as had acquired heat from the lungs or bodies of the patients.

From these observations, and from various facts of a medical nature, which the Committee communicated, it became apparent, that a due ventilation of the Hospital could only be obtained by a thorough diffusion of fresh air through the several wards, not in large masses which do not blend with the general atmosphere, but in small jets, on the principle so successfully adopted by Dr. Reid, for ventilating the House of Commons.

The limited pecuniary means under the control of the Medical Committee required that any alteration to be made on the existing system of ventilation, should be done at the least expense; and that the apparatus then in use should, as far as possible, be made available for the purposes in view, notwithstanding of many serious objections to the principles of their construction.

Accordingly, a conduit was carried round two of the wards, from the aperture heretofore used for introdu ing warm air, and perforated with holes in a certain ratio of number to the distance, so as to insure an equal diffusion of quantity at every place. This conduit was made of wood, from it being a non-conductor of heat, so that the air discharged at the further extremity of the conduit into the ward, should, as far as possible, have the same temperature as that at the beginning, —the instructions of the Medical Committee preventing the use of any woollen, or other fibrous substance, as a coating, to prevent the radiation of heat from a metallic conduit.

As a further aid to the equable diffusion of air, another conduit was placed along the ceiling of the ward, perforated with holes, and communicating with a tube of considerable capacity, (also of wood,) which passes through the entire height of the hospital, and terminates above the roof. The column of heated air in this tube, by its levity, creates a continuous draught of air from the wards by the upper conduit; consequently, from the exterior air through the warming apparatus into the wards,—and thus independent of the attention, and beyond the control of the nurses, a perpetual change of air is maintained.

In regard to the ventilation of hospitals, there are circumstances not sufficiently known, but essential to the formation of a design, which shall not merely embrace an ample supply of air, but the proper temperature at which this air should be transmitted.

When the quantity of air required by a person in health, is estimated by weight, it appears that not less than 55 pounds per day is consumed or vitiated by each individual; and there appears a strong probability that the weight vitiated or rendered poisonous by a person in the height of a fever is much greater. If the most important consequences in medical treatment be obtained by a slight alteration in the quantity or description of food, which, estimated in like manner by weight, is but a fraction of the quantity of air, there is ample room to imagine that any alteration in the circumstances of air, may have a proportionate influence on the patient. The extent of ventilation, the temperature, the degree of moisture or dryness of the air to be supplied to persons under treatment, should be placed as much under control of the medical officers, as any other article of nourishment; and it would be important had they the means of testing by experiment, the effects of what may be termed *artificial climate*, in the treatment of various diseases under their care.

VIII.—*Description of an Improved Tilting Apparatus, for emptying Waggons at the Termini of Railways, Shipping Places, &c., as used at the Magheramorne Lime Works. By* James Thomson, Esq., F.R.S.E., M.R.I.A., *Civil Engineer.*

The apparatus may be generally described as consisting of three parts, viz.:—

1st. The cast-iron brackets or quadrants, for supporting the machine, *a*, *a*, *a*.

2d. The tilting frame upon which the waggon is placed, *b, b.*

3d. The malleable iron swings for suspending the frame to the brackets, *c, c.*

The supporting brackets, *a, a,* are bolted to the wooden frame, *d, d,* of a moveable shipping platform, by means of which the apparatus is advanced at pleasure, and made to project beyond the wharf, so as to discharge the waggon immediately over the hold of a vessel.

The tilting frame is formed of two cast-iron cheeks or sides, having in each two slots or grooves for attaching to the swings, and for adjustment of the apparatus. These sides of the frames are connected together by two flat malleable iron slugs, *e, e,* as represented in fig. 2, with a bolt in each end, and a light round iron stay, *f,* at the curved ends.

The swings are attached to the frames by means of snubs, *g, g,* which are bolted vertically to the lower ends of the swings, and horizontally to the sides of the frame, the bolts passing through the grooves or slots already mentioned, in which they are moveable. The upper ends of the swings work upon malleable iron journals, fastened in he top of the cast-iron brackets.

When the apparatus is properly adjusted, (which is done by moving the tilting-frame forward or backward upon the swings, by means of the adjusting slots,) the waggon, on taking its position, should be so placed that its *centre of gravity may be slightly in advance of the point of suspension.*

The rails to the tilting frame are laid with a gentle declivity, so that the waggon may be brought upon it with a slight impetus, just sufficient to set the frame in motion; the waggon will then immediately fall into a position ready for discharging, as shown in fig. 1, when, by a simple contrivance, which may be effected in various ways, the door of the waggon is opened from behind by a handle and connecting rod, communicating with the door latch, and the load is discharged.

While loaded, the tilted position of the waggon will of itself remain the same, being in equilibrio; but immediately it is discharged, and consequently the *centre of gravity thrown behind the point of suspension,* the tendency is then to resume the horizontal position, which it is, however, prevented from doing, by means of the spur, *h,* until completely emptied; the spur is then disengaged, and the waggon resumes its level position, ready to be removed.

The whole operation of discharging a waggon, of whatever weight, is effected with perfect safety and facility in a few seconds; and one very important desideratum is supplied by this apparatus, viz., *the practicability of discharging waggons of different dimensions and different sized wheels upon the same tilting frame.*

The advantages of the apparatus have been fully tested at the Magheramorne Lime Works, in Ireland, where they were first applied; and have since been in constant operation for the last three years, discharging waggons of three tons, with 24 inch wheels, and waggons of only 20 cwt. and 20 inch wheels, with perfect facility and expedition The cost of each apparatus does not exceed from £10 to £11 complete.

Fig. 1.

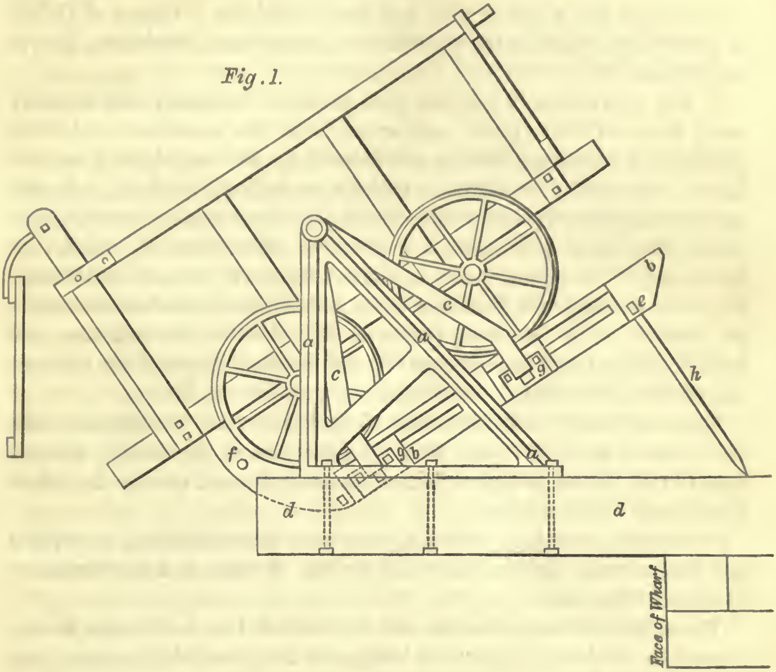
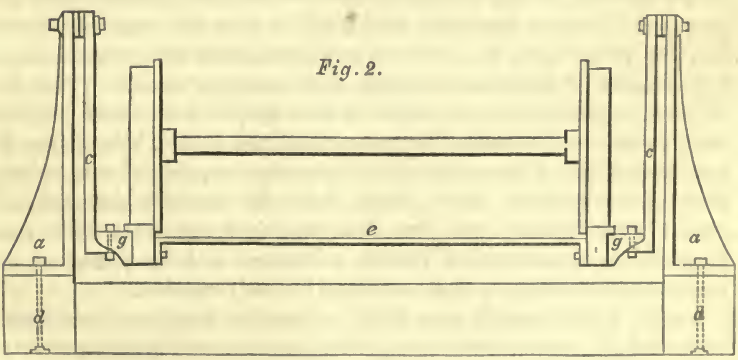


Fig. 2.



9th February, 1842,—*The* President *in the Chair.*

IX. *On the Physiology of Cells. By* Andrew Anderson, M.D. *Andersonian Professor of the Institutes of Medicine.*

A sketch was given of what has been called the "Theory of Cells," in physiology, based on the observations of Schwann, Schleiden, Barry, and others.

It was shown that it has now been rendered probable, that not only every tissue of every plant and animal, but the secretions and other products of organized beings, are formed in one way, by the spontaneous evolution of transparent vesicles, or cells full of fluid, and containing the germs of future cells, which are subsequently formed within them; that these cells possess a power of absorption, by which they increase by the appropriation of matter from without; of transformation, both in respect of their own form, and of these absorbed materials; and that it is by the living power of the cells that the nutrition and reproduction of the tissues goes on, and, in short, that all the changes are effected, by which we recognize the presence of life.

That the beauty and simplicity of this theory are unsurpassed, and that while it seems to have marked a new era in physiology, the evidence in its favour is such as almost to make it rank among the established facts of the science.

[Specimens, drawings, and diagrams were then exhibited, to explain and demonstrate the structure and growth of cells, and the formation of tissues from them.]

The subject of reproduction was next alluded to, and it was shown, that while the lowest organized beings, as the yeast-plant, consist but of a single cell, by the multiplication of which they increase and are propagated,—so we conclude, that while in them the simplest expression of a living being is a cell, the same holds true with respect to the higher ranks of plants and animals, and even man himself. That the embryo is formed by the union of two simple cells, which include within them, not *actually*, but *potentially*, the future being; that is, which have within themselves a living energy, capable of successively forming the parts of such a being, from the nutritive materials absorbed from without; and thus, that *organized life*—that which man possesses in common with plants, is identical with the powers of the microscopic elementary cells of which his body consists.

Lastly, a few remarks were made to show the bearing of this theory on pathology; how it is that many diseases may arise from a perverted state of the vital action of cells; how others, as the *porrigo*, evidently depend on the formation of abnormal cells, putting on the aspect of organized beings of the lowest class; and the paper concluded by general remarks on the extreme interest and the practical importance of the subject.

14*th February,* 1842,—*The* PRESIDENT *in the Chair.*

This Meeting was called for the purpose of receiving the following Report from the Section on Physiology.

X.—REPORT OF THE SECTION ON PHYSIOLOGY, *On the best Means of Supplying the Poor with Cheap and Nutritious Food.* Read by DR. R. D. THOMSON.

MUCH difference of opinion has at various times existed, respecting the proper origin of the food of man. Some have traced its legitimate source to the vegetable kingdom, while others have denounced any diet as bad, which did not contain a certain admixture of animal food. The former have been sustained by the fact, that numerous tribes of human beings subsist upon vegetable food alone; while few if any, have been met with, whose sole means of subsistence are derived from the animal world. This objection, however, we believe to be obviated in the natural history of the Esquimaux. During at least the winter season of the year, these remarkable human anomalies appear to subsist almost entirely upon the carcases of marine animals, and contrary to the results which have been obtained by the French commission, in feeding dogs upon fat, the Esquimaux feast upon blubber and retain all their functions and faculties unimpaired. We have, therefore, presented to us, in striking contrast, the inhabitants of the torrid regions of India, existing upon vegetable food alone; and the Esquimaux on the skirts of the frozen sea, thriving upon the grossest part of the animal kingdom.

If the question were to be raised, whether is vegetable or animal food most nutritive, and most capable of sustaining animal life *per se?* perhaps there would be little hesitation in yielding the palm to the former, inasmuch as all animal matter is in reality a modified form of the produce of the vegetable kingdom. In the wheat plant for example:—by the influence of vegetable organism—carbonic acid, ammonia, water, are converted, in conjunction with sulphur and phosphorus, into albumen or gluten. The latter substance when transferred into the stomach is digested and deposited in the solid form, denominated albumen or fibrin, without undergoing any alteration in its chemical constitution. The vegetable organism is, therefore, the original source of muscular fibre. The constituents of the fibre have been produced by the plant from gaseous elements. Indeed, there appears no evidence to favour the idea, that any solid is produced from gases in the animal system. On the contrary, vegetables seem to be the creators, if we may so speak, of all solid organic matter. Without vegetable matter then, it is obvious no animal substance could exist. For in the animal system all the actions which have been demonstrated, are of a decomposing or modifying tendency, and we believe, never of a character calculated to produce solid matter from its primary elements. If these premises are correct, then it is evident, that we are to look for the source of all nutriment in the vegetable kingdom, and we are to expect that these substances will be best calculated for the nourishment of animal life, which, in their composition, approximate to the constitution of animal matter. The characteristic of this common character is azote. Unless vegetable matters contain this substance, they are inferior in the nutritive scale; although they must by no means be considered as destitute of all nutritive power.

But the quantity of animal food consumed in a cold country ought, undoubtedly, to be greater than in a warm climate; because, as all animal heat is produced by respiration, the quantity of heat required under the former circumstances, is necessarily greater than in the latter. Animal heat is the result of the union of the oxygen of the air with the carbon of the food. To produce more heat, therefore, more carbon must be employed—a more condensed form of carbon must be used. This is animal food.

Sugar is a substance which contains no azote, and yet appears to afford nourishment. In crop-time, according to Dr. Wright, every negro on the plantations, and every animal, even the dogs, grow fat; and Humboldt (New Spain, II. 424) has frequently observed, that the mule drivers, who carried his luggage on the coast of Caraccas, gave the preference to unprepared sugar over fresh animal food. Gum, also, which possesses a composition identical with sugar, serves for nourishment to several African tribes in their passage through the desert. Who would venture to affirm that potatoes are not nutritive, upon which so many thousands of our fellow creatures are almost dependant for their subsistence? They, however, contain no gluten, according to Proust, and very little azote, according to Boussingault.

Relative Nutritive Power of Vegetables.—To Boussingault we are indebted for an elaborate series of experiments, on the quantity of azote in vegetables, which may be presented in a tabular form, so as to exhibit the equivalent nutritive power of each vegetable, as indicated by the quantity of azote. Unity represents the most nutritious substances, and is considered equal to the larger numbers, (*Annal. de Chim. Vol.* 63.)

White French Beans,	100	Flour of Barley Meal,	212
Yellow Peas,	120	Potato Flour,	225
Flour of Cabbage,	148	Barley,	232
Flour of Carrots,	170	Indian Corn,	246
Flour of Wheat,	175	Potatoes,	1096
Wheat,	191	Carrots,	1351
French Wheat,	193	White Cabbage,	1446
Rye,	200	Turnips,	2383
Oats,	210		

This table is read thus:—100 parts of white French beans are equal to 200 parts of yellow peas, or 2383 parts of turnips, in supporting the strength and vigour of animals fed upon them. The one may be as nourishing as the other, if a sufficient quantity is taken. If a person were accustomed to use 1¾ lbs. of wheat flour, for his support during a certain period, and his diet were changed to potatoes, he would require 11 lbs. of the latter vegetable to sustain the same degree of vigour. This is a most important fact; because it proves that if the body though fed, is not *sufficiently* fed, starvation may ensue.

These are what may be deemed the theoretical indications of nutritive power, but they agree in such a close manner with the practical numbers, deduced by agriculturists who have derived their facts from feeding cattle, that there can be little doubt, at least, of the practical value of the table.

In the following table, the first column represents the nutritive power, determined by the quantity of azote. The second represents practical experience in feeding cattle.

	Theoretical Equivalent.	Practical. Equivalent.
Hay,	100	100
Yellow Peas,	31	30
Wheat,	49	27
Rye,	51	33
Oats,	54	61
Barley,	59	54
Indian Corn,	63	59
Potatoes,	281	200
Carrots,	347	319
Beetroots,	400	397
Turnips,	612	607

By a careful inspection of these tables, we infer that substances are nutritious in proportion to the amount of albumen, or gluten, as it is more commonly termed, which they contain. Peas contain a large quantity of this vegetable principle, and accordingly they are highly esteemed by feeders of stock, at least in France. Hence, we have suggested to us, the propriety of mixing peas with wheat flour when the latter is of bad quality, which is certainly the case with some met with in Glasgow, of last year's growth. In some chemical works we find the quantity of glutten in wheat flour, estimated as high as 24 per cent. A specimen analysed by Dr. R. D. Thomson, was found to afford only 6 per cent. of gluten, dried at the temperature of 212°.

It it not easy to discover the object, which the introducers of fermented bread had in view, when they superseded unleavened bread in domestic economy. If any one were asked, what advantage fermented bread possesses over baked dough, the answer would probably be that it is lighter; at least, this is the answer generally received, when the question is asked for information. Now what is meant by the term light—when applied to bread? Does it mean less specific gravity; or has it reference to the greater facility of digestion; the former signification alone, we suspect, can be attached to fermented bread; we never hear any complaints from the working classes, that their oat-cakes or barley bread are more indigestible than loaves of wheat flour, or that potato bread is not light enough for digestion. The Jew does not labour under indigestion, when he has laid aside his leavened bread during the passover, and substituted in its stead unleavened cakes. The same observation applies to the *scones* of our own country, and to those of India; for the natives of that country, from Delhi to Cabool, are scarcely acquainted with any other kind of bread. Biscuits are classed in the same category, and are even given to invalids, when no other variety of bread can be swallowed by the patient. But it is believed, that all these forms of unfermented bread, may be improved by chemical means, so soon as scientific care shall be bestowed upon this important branch of man's comfort. In London, there is at present an excellent variety of bread baked without fermentation, but deprived of its doughy character, by being raised by the action of muriatic acid upon carbonate of soda. Its taste is perfectly sweet and good, and its digestive property unexceptionable. The common salt which is produced by the chemical action, will, undoubtedly, be advantageous.* Butter-milk scones are made on this principle. So far therefore as digestibility is concerned, the scale does not seem to preponderate in favour of fermented bread. Let us suppose them equal, although there may be arguments in favour, even of the unfermented bread. But let us view the question in another aspect, and consider in what panification consists, as it has been called, as if bread could not exist without fermentation. A certain quantity of water and yeast is mixed with flour, and the whole formed into a dough. The latter is exposed to heat. Carbonic acid is disengaged, by the action of the yeast upon the sugar of the flour, and alcohol is likewise extricated. In other words, a greater or less proportion of the sugar, an important element of the flour, is totally destroyed and dissipated in the air—in the form of fixed air and whiskey. With these considerations before him, Dr. R. D. Thomson had his attention directed to the subject. He was anxious to ascertain, what was the actual amount of loss sustained, in a given quantity of flour. This brings us, therefore, to the economical view of the question. An experiment was made, in the bakehouse of Mr. Dodson of Southwark, upon a large scale, with fermented and unfermented bread. The result was, that in a sack of flour, there was a difference of product in favour of the unfermented bread, to the amount of 30 lbs. 13 oz., or in round numbers, a sack of flour would produce 107 loaves of unfermented bread, and only 100 of fermented bread of the same weight. Thus it appears, that in the sack of flour, by the common process of baking, 7 loaves or 6½ per cent. are blown to the winds. The question for consideration is, does the loss consist entirely of sugar, or is there any other element of the flour depreciated? By a mean of 8 analyses of wheat flour from

* Mr. Henry of Manchester *first*, we believe, suggested the idea of this process, at the end of last century, and Dr. Hugh Colquhoun of Glasgow, in 1826, (Annals of Philosophy, xii. N.S.) carried the idea into practice.

different parts of Europe, by Vauquelin, it appears that the quantity of sugar contained in flour, amounts to 5.61 per cent. But the quantity lost by baking exceeds this by one per cent. nearly. We must, therefore, look to some other ingredient in accounting for this loss. It has been supposed by some, that the ferment possesses the power of converting a portion of the starch into sugar. We are not aware, however, that any proof has been adduced of this position. It is well known, that a portion of the starch is converted into gum, or at least, that in fermented bread, a quantity of gummy matter can be detected, which did not exist in the flour. Now we believe it is by the viscous fermentation, a process quite distinct from the acetous fermentation, that this gum is converted into lactic acid, which may proceed to a great extent, if its progress is not checked by a baking temperature. We have been able to procure lactic acid in considerable quantity from the liquor of sowans; and we believe the rationale of the process by which this acid is produced, is that now explained. We are not aware of any rationale which could be applied to the explanation of the production of sugar from starch, by means of yeast; but with the appearance of gelatinous or gummy starch, most people are familiar. From these considerations, it would appear that we must look to some other source for the loss sustained during the baking of fermented bread. Liebig has well illustrated the fact, that when yeast is added to wort, ferment is formed from the gluten contained in it, at the same time that the sugar is decomposed into alcohol and carbonic acid. We may therefore expect, that in panary fermentation, which is precisely analogous to the fermentation of wort, the gluten of the flour will be attacked, to reproduce yeast. It is to this action, therefore, upon the gluten, that we are inclined to attribute the excess of loss, over the quantity of sugar contained in flour, which we have described as taking place during the baking of bread.

Dr. R. D. Thomson has attempted to produce a wholesome and palatable bread, by the employment of ammoniacal alum and carbonate of soda, or ammonia, as a substitute for yeast. In this process the alum is destroyed; the bread is vesicular, and rises, according to the judgment of the baker, as well as fermented bread. It possesses the advantage of retaining the natural sugar of the flour undecomposed. It is white, which bread raised by carbonate of soda and an acid, seldom is.

The experiments of Magendie show, that animals, when fed on sugar alone, speedily fall off. He took a dog of three years old, fat and healthy, gave it pure sugar to eat, and distilled water to drink, and with these the animal was liberally supplied. For eight days it appeared to thrive. During the second week it began to get thin, although its appetite continued good. In the third week it became still thinner and weaker, and an ulcer appeared on the cornea of each eye. On the thirty-second day it died, although it had eaten three or four ounces of sugar per day, till within a short period of its death.

Sugar, we have stated, is one of the constituents of flour, and such was the effect of feeding animals upon it alone. *Starch*, another more important constituent of flour, was also given to animals, *per se*, with a remarkable result. In the pulverulent form dogs would not even look at it. When made into a paste with water, dogs, rather than taste it, preferred to die of starvation. Even when cooked with butter, lard, sugar, or bread, they refused, generally, to make use of it, and if some did take it for a certain time, they never failed to perish of starvation.

The effects resulting from feeding animals upon *gluten* alone, are highly worthy of attention. The gluten was prepared from wheat and from Indian corn. It was taken by dogs without difficulty on the first day, and the animals continued to live on it for three months, without any interruption,—the amount swallowed by each daily being about four or five ounces.

What is usually termed gluten, contains, mixed with it, other substances, which are soluble in alcohol. The residual portion, after this treatment, is pure vegetable albumen, being identical in composition with the curd of milk. The fact deserves attention, that foreign wheat contains a much greater amount of albumen than that of this country. Odessa wheat contains, according to Vauquelin, 14½ per cent. French wheat 11 per cent. Vogel found in German wheat 22 per cent., and Zeimenck 15 per cent. We have already stated, that by experiment, only 6 per cent. existed in Glasgow flour of last year's growth. Vegetable albumen, of the same composition, and possessing the same properties as gluten of wheat, is found in large proportion in peas and beans. The common pea contains 18½ per cent. of albumen; kidney beans 18¼ per cent. We have therefore suggested to us the importance of peas, in a nutritive point of view, and the propriety of their admixture with other articles of food. For example, in soups, a sprinkling of peas would produce a body in the soup; and this observation applies to soup intended both for the rich and the poor. Care should be taken, however, that they should be well boiled, and if allowed to digest for a day previous to use, in water at the temperature of blood heat, as is done with seeds before sowing, they would be softened, and even partially dissolved. The water in which they are digested might be employed for the purpose of making the soup. Cabbage, according to Boussingault, is a very nutritive substance, and, in the form of powder or flour, we can employ it in mixture with soup, in a less bulky state than under the usual form.

Peas afford a means of increasing the nutritive property of different kinds of meal. Most persons are familiar with the mixture of peas and barley-meal, which affords a wholesome bread. Peas-meal might also be mixed with oat-meal, in the same manner, if considered expedient.

We have hitherto confined our attention to vegetable food. Experience, however, shows, that the diet of man must be varied, and must not be restricted to the vegetable kingdom. It was at one time considered that scurvy could only be produced by the use of salt provisions. More careful inquiry has, however, demonstrated, that scurvy may be engendered by restriction to one class of food,—that even vegetable food possesses both a scorbutic and anti-scorbutic agency, under particular circumstances. Scurvy frequently attacks the Indians in S. America, who live on rice almost alone. It has reigned epidemically in the rice grounds of Lombardy and Piedmont. Scurvy prevailed in an epidemic form in Germany, in 1771 and 1772, years of scarcity, when many of the inhabitants were obliged to live on legumes, roots, and even the bark of trees; and the same disease affected numbers of the poor people of France, in 1812, 1816, and 1817, when even wild plants were employed as food, in consequence of scarcity. In the winter of 1794–95, scurvy not only broke out in the channel fleet, but also appeared on shore; and cases were admitted into the London hospitals.

In the lunatic asylum at Moorshedabad, one-third of the inmates are annually affected with scurvy. Their diet consists of rice, split peas, curdled milk, oil, salt, pepper, water, all good of their kind.

The deleterious effect of a bread and water diet upon the prisoners in the gaols of Bengal and Agra, is sufficiently evinced by the fact, that the mortality among the prisoners was 66 per thousand, in 1833, while among the native troops the mortality was only 10·6 per thousand, (Brit. Annals of Med., p. 491.) How far such treatment of men falling into error is congenial with the benevolent doctrines which "desire not the death of a sinner, but rather that he should turn from his wickedness and live," this is not the proper place to inquire.

Scurvy, however, is a disease which denotes a bad state of the system, from want of nourishing food, and a proper admixture of the food which man was destined to exist upon. A want of succulent food appears to produce the same state of system. The famous disease at the Milbank penitentiary, in 1823,—a mixture of scurvy and dysentery,—was attributed to a diet, of which succulent vegetables formed no part, and the quantity and quality of which were not adequate to the support of health. Scurvy, therefore, is one of the forms in which starvation, or bad nutriment, which amounts to the same thing, exhibits itself; and it has been traced to its true cause, after its occurrence for hundreds of years, because it was detected in gaols and mad-houses, and was subjected to careful examination. How many other forms starvation assumes, no one knows. From the Registrar General's Report for England and Wales, in 1839, it appears that 130 persons died of starvation, that is, purely from want of food, or direct starvation, as it may be termed, for it now occupies a distinct head as a disease in the bills of mortality; but how many persons died by piece-meal starvation, or disease engendered by bad food, or want of it, has not yet been pointed out by statistical data. Numerous points for inquiry, however, present themselves to the medical statistician in considering this question. How far are typhus, scarlet fever, and other diseases of large towns, influenced by bad and imperfect nutriment? And how far does the restriction to meagre vegetable food operate upon mortality in Scotch towns? These are important considerations in Glasgow, where the rate of mortality is higher than in the average of large towns; indeed, greater in some years than that of the worst parts of London. The following table shows this:—

		PER CENT.	
Mortality of England and Wales,		2·17	
	Whitechapel, London,	3·86	1838.
	Glasgow,	3·23	1841.
		4·15	1837.
		3·53	1836.
		3·26	Mean of last 10 years.
	Liverpool,	3·18	1838.
	Manchester,	3·45	1838.
	Birmingham,	2·58	1838.
Average Mortality of Towns,		2·62	1839.

The mean duration of Life in Great Britain is about 46; in Glasgow, 30·6,—mean duration in towns, 38 years.

The burden of all this starvation and mortality, of course, falls upon the poor and helpless. It is only, therefore, the duty of those who are in better circumstances to be aware of the facts, that they may be remedied.

Experience, the structure of the teeth, and of the digestive organs of the human body, as well as the appetite, demonstrate, that the flesh of animals should enter as an element into the food of man.

Some kinds of animal food are digested with greater rapidity than vegetable food.—Bread and coffee take about 4½ hours to digest; fresh beef, from 3 to 3½ hours; salt beef, from 3½ to 5½ hours; salt pork, from 4½ to 6 hours; mutton, 3¼ to 4½ hours; fowls, 4 hours; veal, from 4 to 5½ hours; tripe, 1 hour; pig's feet, 1 hour. But these numbers depend considerably upon the circumstances under which the food is swallowed. If the quantity taken be in excess, slow digestion is the consequence; and the same holds good with regard to passions of the mind. Exercise also promotes digestion. It is interesting to know, that those substances which are most nutritive, are not those which are most rapidly digested. Gluten, which, according to Magendie, is exceedingly nutritious, has been found in the stomach unaltered five hours after being swallowed. Pig's feet, on the contrary, which are digested in an hour, contain a large proportion of gelatin, or jelly, which, according to the experiments of Magendie, possesses very inferior nutritive properties.

To those who are in good circumstances, any of these substances may be procured at pleasure. It is when looking at the poor, that we must view them in an economical point of view; and with them the point is not how to excite an appetite, but how to satiate it in the cheapest and most substantial manner. Papin was the first individual who introduced the method of preparing food from bones—by exposing them to the action of water and steam, under pressure, in his digester. By this means a greater quantity of gelatin, or animal matter of the bone was dissolved than could be procured by simply boiling bones in water, at the ordinary temperature of the atmosphere. This mode was afterwards applied to the supply of nourishment to the poor by the D'Arcets, who both engaged in the attempt with most laudible enthusiasm. According to the younger D'Arcet, when the bones of four oxen are properly exhausted, a fifth is in reality created. A method was introduced at some of the hospitals in Paris, for extracting gelatin from bones, at the suggestion of D'Arcet. At the Hotel Dieu, bones which have been previously twice boiled—once in the morning to make common soup, and again in the evening to make *bouillon maigre*, are deprived of their cartilages and fibrous cartilages. They are broken, and placed in iron cylinders, and are exposed for four days to the action of steam, raised to the temperature of 219° to 221° Fahr.

This gelatinous liquid contains in 88 gallons,

11·79 Troy lbs. of gelatin.

This is then employed to form a broth, by adding a certain quantity of soup made with meat and vegetables. The evidence of those who have examined this compound soup, is highly unfavourable. The gelatinous liquid when taken out of the iron cylinders is highly disagreeable, and even excites nausea. The odour becomes less unpleasant after the liquid has stood for some time. This improvement in the smell appears to depend in some measure, upon the escape of ammonia, which has been generated by the strong heat and prolonged action of the steam. It likewise imparts its impairing properties to the soup made from the meat, and causes a truly disgusting odour, (*une saveur un veritable degout.*)

We think that these facts are sufficiently condemnatory of the process of extracting gelatin under long continued pressure from bones, and may receive some degree of explanation from a specimein which we have examined of the tusk of an elephant; in which, probably, by the action of hot sand and pressure, the tusk is seen in the act of being gradually converted into a mass of glue, retaining the original figure of the tusk. So that, instead of being obscured under the title of solution of gelatin, perhaps, the true nature of the French soup for the poor, would be better expressed by the title of glue-soup. Indeed, this is put beyond mere surmise, by the fact stated by the French commission, that the solution of gelatin when evaporated left a hard extract presenting the characters of Flanders glue.

We think it possible, however, that a gelatinous solution might be obtained from bones, by high pressure steam, if desirable, without its possessing an ammoniacal or other disagreeable odour. This, we presume, from a carefully conducted experiment, in which a bone which weighed 1442·5 grains lost by exposure for an hour to a temperature of 230° in a Papin's digester, 208·6 grains or 14·5 per cent.

The resulting liquid possessed a highly agreeable odour, nor was the slightest ammoniacal smell perceptible.

The advantage of a considerable elevation of temperature we have mentioned, is obvious, when the preceding experiment is contrasted with another trial made by boiling a bone at the common temperature of boiling water. A bone weighing 12 oz. 315 grains lost after 1½ hours boiling in a common pot, covered by a lid, under which the steam had free space to escape, 358 grains or equivalent to 5·9 per cent.

Both of the bones were beef-bones, and flat, resembling each other as nearly as possible. The extract left by the evaporation of the liquid, derived from boiling the bones at a common temperature, was a trembling jelly, and did not resemble glue.

According to the French commission, the effect of feeding dogs upon gelatin extracted by hot water, was similar to that produced upon the same animals when they were fed exclusively upon any elementary animal substance, as fibrin, and albumen, &c. Several dogs preferred to die rather than touch it, while others partook of it once or twice, and then obstinately refused to make further use of it. The result was different when the gelatin was derived from bones by the action of an acid. If the bones were digested in acid, and the residue dissolved in water, dogs lived upon it for a month and were well nourished, especially when the bones were those of sheep's feet. But after this period they showed a dislike to their monotonous meal. We believe, therefore, that gelatin procured by the action of acids upon bone, might be employed as the basis of soups, which should however contain also meat and vegetables. The latter should always, to a certain amount, be of a succulent nature. It is desirable, however, that in our climate, animal food should always constitute a part of the diet of man; whether he be in the condition of a pauper or a prisoner. If a man is poor and is imperfectly nourished, he may die of starvation ultimately, as truly as the man who is totally destitute of the necessaries of life. And if a man is deprived of his liberty for the benefit of his fellows, there is no reason, human or divine, why his health should be injured by inefficient food, so as to produce death by slow starvation. The consequence is more cruel than if he were at once capitally punished.

From the observations which have been adduced in the course of this Report, it appears that—

1. A considerable loss is sustained in the amount of flour employed in baking bread, when the flour is fermented. This loss exceeds a fifteenth, being 6½ per cent. If we apply this correction to the ex-

pense of the Night Asylum for the Houseless, where several thousand dinner rations are distributed daily, we shall find the loss as follows:—

On Soup and Loaf Bread to 1,500 persons.

Quantity for 1, in Ounces.	Quantity for 1500, in Pounds.						
2½	234	Ox heads, ...	@ 1½d. per lb.		1	9	3
½	47	Bones, ...	1½d.	do.	0	5	10½
2	187	Pot Barley, ...	1½d.	do.	1	3	4½
½	47	East India Rice, . . .	1½d.	do.	0	5	10½
½	47	Vegetables, ...			0	7	10
½	47	Pease Meal, ...	1¾d.	do.	0	6	10¼
	1	Black Pepper, 1s., Salt, 1s., .			0	2	0
6½	609	Wheat Bread, (Second,) . .	1¾d.	do.	4	8	9¾
		Add for Coals, Cooking, and Serving, say			0	17	7½
13	1219				£9	7	6
		Deducting from the Bread a fifteenth,			0	5	11
					£9	1	7

Thus it appears, that the allowance to each person for dinner, is 6½ ounces. At this rate, there being a saving of 40 lbs. of bread by the unfermented plan; the saving would supply 98 additional persons with bread, or a larger allowance might be granted to the others.

2. It is highly necessary, that in order to retain the human constitution in a healthy condition, variety of food should be properly attended to. (1.) Soups may be used, having as their basis the gelatin of bones, procured either by boiling bones carefully, or by abstracting the earthy matter by means of acids; and pease meal with meat, as hearts, livers, &c., should contain succulent vegetables, as greens, carrots, and turnips. (2.) Soups consisting of potatoes with gelatin and other meat, may also be made very palatable by the addition of succulent vegetables. (3.) A good soup may be made with salt fish well steeped in water, and boiled up with potatoes.

3. If salt fish can be procured cheap, an excellent substantial dish may be formed of fish and potatoes, in the form of a pudding, like a beat potato pudding.

4. In the broths or soups, barley may be used, or rice; but the most nutritious substance for making a body to the soup, is pease meal or split peas, and the least nutritive of farinacious substances is rice.

5. A good soup may be made with salt fish or fresh fish, and split peas.

An alternation somewhat in the following rotation, might be introduced in feeding the poor:—

Breakfast,		Porridge and Milk.
Dinner,	1st day,	Pea Soup, with Meat and Bones.
	2d —	Fish Soup, with Peas.
	3d —	Potato Soup, with Bones and Meat.
	4th —	Fish Pie, with Potatoes.

We trust, that the day is fast approaching when the light of science will enable the guardians of the poor to manage our poverty-stricken fellow-men by precise and definite rules; and will teach all classes of the community that the quantity of vital air supplied by the Creator to man, is based upon fixed laws which require the imbibition of a certain amount of food. An adult consumes every day 30½ ounces of oxygen or vital air, from the atmosphere. To consume this and to convert it into carbonic acid, he requires, according to Liebig, about 13 ounces of carbon, in the form of food. If the food is withheld, the carbon must be supplied from the muscles and substance of the body; the latter becomes thinner and weaker, and like an expiring taper, is extinguished by the influence of the most trivial causes.

SUPPLEMENTARY NOTE,

By ANDREW LIDDELL, *Esq., Treasurer to the Night Asylum for the Houseless, Glasgow.*

IN the Asylum for the Houseless many of the recommendations in this Report have been adopted. The dinner meals are now varied two or three times every week. East India Rice, which can be had at a low rate when purchased as imported, after being thoroughly washed and cleared of its impurities, is used in the soups, and when boiled with Sweet or Skimmed Milk, in the proportion of 1 imperial pint with 4 oz. of Rice, and used with 4 oz. of Oat or Wheat bread, forms an excellent dinner at the cost of about *one penny.* Pot Barley is used in the same manner, and costs nearly the same. The dinner meal stated in page 39, being that which is generally given to the unemployed, has in it 3 oz. of animal food, and 10 oz. of other solids, is acknowledged by the unemployed themselves to be a solid substantial meal, and costs, including fire and cooking, *three halfpence each ration:* a greater proportion of Pease Meal, for the nourishment it contains, would have been given, but for the tendency it has to make the broth black. The change in the dietary routine is much relished by the inmates of the Asylum, and may have had some effect in the greater degree of health which has been evident amongst them of late. Of all the varieties, however, none have been more relished in this house, nor by the boys in the House of Refuge, where similar changes have been made, than the following three, all of which are very savoury, and produced at a moderate rate. For the purpose of being more generally known, the quantities found sufficient to make a comfortable meal, and the average rates at which the materials can be purchased, are here given in a tabular form, calculated for ten individuals, showing the cost of each meal. But the same dishes could be had at about the same relative cost, though the number did not exceed five.

Fish Pudding for Ten Persons.

Quantity for 1.	Quantity for 10.			*s.*	*d.*
2 lbs. 0 oz.	20 lbs. 0 oz.	Potatoes, . . .	@ ¼d. per lb.	0	5
0 — 8 —	5 — 0 —	Salt Ling, or other Fish,	2d. do.	0	10
0 — ¼ —	0 — 2½ —	Of Lard or Drippings,	8d. do.	0	1½
		Pepper, ...		0	0½
2 lbs. 8¼ oz.	25 lbs. 2½ oz.			1	5

Cost, exclusive of Fire and Cooking, under 1¾d. for each person.

Steep and boil the Fish as long as the saltness and size of the article to be used requires, take out the bones, boil the potatoes in a separate vessel, beat the whole together. If a fire or oven can be had, brown the top of the dish.

A Stewed Hash of Sheep's Draught for Ten Persons.

				s.	*d.*
2 lbs. 0 oz.	20 lbs. 0 oz.	Potatoes, . . .	@ ¼d. per lb.	0	5
0 — 5½ —	3 — 8 —	Two Sheeps' Draughts, .	5d. each.	0	10
0 — 0 —	0 — 8 —	Onions, 1d., Pepper, Salt, and Flour, 2d.		0	3
2 lbs. 5½ oz.	24 lbs. 0 oz.			1	6

Cost, exclusive of Fire and Cooking, full 1¾d. for each person.

Boil the Lights for one hour (preserving the water); hash said Lights, Liver, and Heart together with Flour, Pepper, Salt, and Onions; then stew the whole for one hour, using the water in which the Lights were boiled. The boiling and stewing should be done over a very slow fire.

A Mince of Cow's Heart for Ten Persons.

				s.	*d.*
2 lbs. 0 oz.	20 lbs. 0 oz.	Potatoes, ...	@ ¼d. per lb.	0	5
0 — 4 —	2 — 8 —	Half a Heart, . . .	1s. 6d.	0	9
0 — 0 —	0 — 8 —	Onions, 1d., Pepper, Salt, and Flour, 1d.,		0	2
2 lbs. 4 oz.	23 lbs. 0 oz.			1	4

Cost, exclusive of Fire and Cooking, full 1½d. for each person.

Cut up and wash the Heart well. Mince it very small, adding Onions, Flour, Pepper, and Salt. Stew the whole over a slow fire for two hours.

Printed by BELL AND BAIN, Glasgow.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTIETH SESSION, 1841-42.

CONTENTS.

23d February, 1842,—*The* PRESIDENT *in the Chair.*

Mr. Crum stated, that the Council had had under their consideration the propriety of publishing Abstracts of the Proceedings of the Society, and Dr. R. D. Thomson enumerated some of the advantages to be expected from such a publication. A Committee was appointed to report on this subject. The following communication was then read:—

XI.—*On Dynamometrical Apparatus; or, the Measurement of the Mechanical Effect of Moving Powers. By* PROFESSOR GORDON.

THE correct measurement of the mechanical effect developed by moving powers has long been a desideratum, and numerous Dynamometers have been invented and applied to this purpose; but in Britain there is none known to have been used which can be depended upon, and of which the indications are not in a great measure subject to the discretion of the observer.

During a visit to Metz, in 1839, the author saw the various Dynamometrical apparatus of M. Morin, of which this paper gave a detailed account.

The fallacy of making the product of the *effort* and the *duration* the measure of the mechanical effect was first demonstrated, and it was shown that it is the product of the *effort* and the *distance through which it is exerted*, which should be obtained directly from a Dynamometer, and *not the quantity of motion*, as has been too frequently done.

In order that a Dynamometer may be a convenient and accurate instrument,—1st, Its sensibility should be proportioned to the intensity of the efforts to be measured, and ought not to alter by usage. 2d, The indications of the efforts must be registered independent of the attention, the will, or the preconceived notions of the observer, and, consequently, should be furnished by the instrument itself, by means of lines traced, or other results available at the conclusion of the experiment. 3d, The effort exerted at each point of the space passed through by the point of application of the power should be ascertained, or, the effort at each instant of the duration of the observations. And 4th, If, from the nature of an experiment, it must be of long continuance, the apparatus must admit of easily *summing* the amount of mechanical effect expended.

The beautiful idea suggested by Poncelet of *integrating* mechanically the EFFORT as a function of the *distance passed through*, was explained in Morin's *compteur;* and it was shown that M. Morin's Dynamometrical apparatus completely fulfils all the conditions above laid down.

Full size drawings of the Dynamometers as made for experiments on friction,—on the draught of wheel carriages and ploughs,—and on that of canal boats at great velocities,—as also, for application to measuring the mechanical effect expended in working machines, and tools having a rotary motion,—were exhibited and explained. Compared even with the friction brake of Prony, or its modification by Navier, and with a most ingenious Dynamometer for rotary motion, by Mr. Smith of Deanston, of which a model was exhibited, the apparatus of Morin was shown to be a great advancement,—measuring mechanical effect, or work done, with the same precision as bread is weighed.

The application of the apparatus, somewhat modified, to measuring and registering the mechanical effect produced by a steam-engine at its piston, was illustrated by drawings. This application, in the hands of Professor Moseley, has undergone various modifications and improvements; but the *Indicator* * (for the construction of which the British Association granted £100,) has not yet been applied. When completed, it will afford a means of ascertaining the *duty* of steam-engines, infinitely more to be relied upon than those hitherto employed; and its applicability to marine engines and locomotives, as well as to fixed engines, greatly enhances its value.

* Since this paper was read, I have seen Professor Moseley's Indicator applied. The improvements and new adaptations of the principle of Poncelet are admirable. A detailed description and theory of the new Indicator are given in the Reports of the British Association.—L. G.

8th March, 1842,—*The* President *in the Chair.*

Charles T. Dunlop, Esq. elected a member.

The Committee on Publication, appointed at last meeting, gave in a report recommending the publication of the Proceedings. The report was ordered to lie on the table till next meeting.

The following communications were then made.

XII.—*On the Fertilization of Plants. By* Dr. Balfour, *Regius Professor of Botany, in the University of Glasgow.*

Dr. Balfour, in the first place, described shortly the organs of plants which are concerned in fertilization, and alluded more particularly to the structure of the pollen. He showed the various provisions made for protecting the pollen, and for allowing it to be applied to the stigma, and illustrated these in the case of *Orchideæ, Asclepiadeæ, Vallisneria, Stratiotes, Hottonia, Zostera, Aristolochia, Stylidium, Parietaria, Berberis, Urtica, Cornus canadensis, Ficus,* &c.

He next alluded to the heat developed at the time of fertilization, the absorption of oxygen, the formation of carbonic acid, and the conversion of starch into sugar. The experiments of Brongniart and of Vrolik and De Vriese on *Colocasia odora* were detailed.

The structure of the anther, more especially its inenchyma or elastic fibro-cellular coat, and the discharge of the pollen were next considered, and observations were made on the fluid covering the stigma, which by Aldridge is said to be acid, and by Vaucher is looked upon as the nectariferous fluid secreted by glands on the petals.

Dr. Balfour then explained the changes produced in the pollen grain when it came into contact with the stigma, the production of the pollen tube, and descent of the fovilla.

Various theories, he stated, have been brought forward relative to the fertilization of plants.

Schleiden and Wydler conceive that the pollen tube enters the foramen of the ovule, and that its extremity becomes the embryo, a theory supported by Dr. Giraud, who thinks that the position of the embryo seems to indicate that it is a foreign body introduced into the ovule from the outside.

Dr. Carpenter thinks that it is not the pollen tube, but one of the pollen granules which becomes the embryo, and he traces an analogy between this process and what takes place in the lowest algæ as the *Protococcus,* &c.

Mirbel and Spach oppose Schleiden's views, and think that he has mistaken what they call the primary utricle for the end of the pollen tube. They maintain that this primary utricle exists before impregnation, or before the pollen tube is protruded; and that after the influence of the pollen is conveyed to it, the embryo becomes developed. Their experiments were made on the *Zea Mays.*

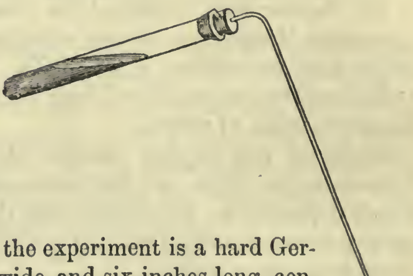
Meyer maintains that the pollen tube becomes united to the embryo sac, and that at the point of union a small protuberance originates, which becomes the germinal vesicle; this vesicle being formed of two cohering membranes, viz., that of the end of the pollen tube, and that of the apex of the embryo sac. The germ vesicle gradually expands in length, and grows into the depth of the embryo sac, becoming a cylindrical tube from the end of which a simple round cell separates, constituting the young embryo.

The opinions of Brongniart, Endlicher, Unger, Gleichen, and Bernhardi were then noticed; and the curious experiments of the latter, relative to the hemp plant were detailed, from which he was led to conclude that perfect seeds could be produced without the influence of the pollen.

Dr. Balfour remarked, in conclusion, that he was disposed to adopt the opinion that the formation of the embryo sac and of the primary utricle took place before the emission of the pollen; that the primary utricle was not the extremity of the pollen tube, nor a mere involution of the embryo sac; and that the act of impregnation consisted in the fovilla being brought into contact with the embryo sac, and by a certain unknown influence determining the formation of the embryo-cell.

XIII.—*On an Improved Method of Preparing Oxygen Gas. By* John Joseph Griffin.

Equal parts by weight of Chlorate of Potash and Black Oxide of Copper, well dried and finely pounded, are intimately mingled. This mixture is well adapted for the extemporaneous preparation of oxygen gas. When exposed to a gentle heat, it becomes red-hot, and disengages a rapid current of pure oxygen gas. The best vessel to use for the experiment is a hard German glass tube, about an inch wide, and six inches long, connected by a long and sound cork with a gas-leading tube of not less than half-an-inch bore: a smaller tube will not carry off the gas with sufficient rapidity.



The tube may be half filled with the mixture, and must be placed nearly in a horizontal position, over a small spirit-lamp. The incandescence appears very soon after the flame is applied to the tube. It rapidly extends through the whole mixture, and the operation is then at once ended; the discharge of gas ceases suddenly. What remains in the tube is a dry coarse black powder, resembling gunpowder, which does not adhere to the glass, but can be readily shaken out. It consists of black oxide of copper and chloride of potassium. The latter can be removed by washing, and the former recovered for a repetition of the process, for which it serves any number of times; so that the use of the oxide of copper does not increase the cost of the oxygen gas.

According to the experiments of Berzelius, 1 grain of chlorate of potash gives ·3915 grain of oxygen. Estimating the weight of 1 cubic inch of oxygen gas at ·34 grain, this product is equal to 1·151 cubic inches. I find that 2 grains of the black mixture above described, containing 1 grain of chlorate of potash, give just this quantity of oxygen gas. Hence it appears, that, in this process, the chlorate of potash is completely decomposed, and its oxygen entirely discharged in the state of gas; while, notwithstanding the incandescence that occurs, the black oxide of copper remains unchanged in composition and properties.

Cost of Oxygen Gas Prepared by this Process.—1¾ grain (1·75 grain) of the black mixture produces 1 cubic inch of oxygen gas. This quantity of the mixture contains ·875 grain, or the 8000th part of 1 lb. avoirdupois, of chlorate of potash, the market price of which is at present 4s. per lb. Hence the cost of the gas is as follows:—

8000 cubic inches	for 4s.
1000 —	for 6d.
1 imperial gallon	for 1⅝d.
1 cubic foot	for 10½d.

Advantages of this Process.—It is easy to obtain materials of such a quality as always to ensure the prompt production of pure gas. Excepting a trace of chlorine and a little sublimed salt, both of which are absorbed by the water of the pneumatic trough, the oxygen gas produced by this process is free from all impurities, especially from carbonic acid; one economical advantage of which is, that it can be used for many class experiments, largely diluted with common air. No apparatus is required except a small glass tube, which is not injured by the operation. There is no expense incurred for fuel, no dirt produced, and no danger to be apprehended.

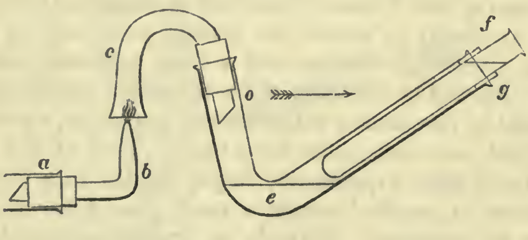
The process is not only of easy and rapid execution, but is one that can be always depended upon, so as to save loss of time and materials. When any quantity of oxygen gas is required, it is only necessary to guage the vessels that are to be filled, and to weigh off 1·75 grain of the black mixture for every cubic inch of gas required. The cause of this certainty in the result is the remarkable incandescence which takes place when the mixture is heated. This ensures the prompt and total decomposition of every particle of the chlorate of potash submitted to experiment.

It is convenient to mark upon the bottle in which the black mixture is kept, the weight of it necessary to be taken for the purpose of filling with oxygen gas the principle gas-holders and receivers which may happen to be in common use. The quantity of mixture in grains required for each vessel is found by multiplying the capacity of the vessel, expressed in cubic inches, by 1·75. Thus, if 100 cubic inches of gas are required, the quantity of black mixture to be taken is $100 \times 1 \cdot 75$ (or $100 + 50 + 25$) $= 175$ grains. For a cubic foot of gas, the quantity of mixture required is $1728 \times 1 \cdot 75$ (or $1728 + 864 + 432$) $= 3024$ grains. In other terms, if x is the capacity of a gas-holder, expressed in cubic inches, then the arithmetical equivalents of $x + \frac{1}{2}x + \frac{1}{4}x$ show the number of grains of the black mixture necessary to be taken to fill the gas-holder with oxygen.

When a large quantity of gas is required, it is best to divide the mixture into several tubes, so as not to heat more than 500 grains of it at once; otherwise the disengagement of gas is inconveniently rapid.

XIV.—*Description of an Apparatus for Exhibiting the Formation of Water by the Combustion of Hydrogen Gas in Atmospheric Air. By* John Joseph Griffin.

Convenient methods of demonstrating well-known facts are often of importance to teachers of chemistry. This principle has induced me to present the following little apparatus, which may sometimes be found useful on the lecture-table. The figure represents a combination of



glass tubes, of which the tube, *o, e, g,* is about 10 inches long and ¾ inch wide, and the tube, *c, o,* about half-an-inch in the bore.

A current of hydrogen gas, dried by chloride of calcium in the tube, *a,* issues from the blow-pipe jet, *b,* and is inflamed. The flame should be about ¼ inch long. The tube, *c,* must be fixed vertically over the flame. The tube, *o, e, g,* must be quite dry. The tube, *f,* must contain cold water. The diameter of this tube is a little less than that of the tube in which it is placed. It is fixed in its position by two small cork wedges, at *f, g,* which are cemented to the tube, *f.*

The heat of the flame causes the atmospheric air to rush into the vertical tube, *c.* The oxygen of the air combines with the burning hydrogen, and forms water, which passes, in the state of steam, mixed with nitrogen and superabundant air, into the bent tube, *o, g.* The steam there comes into contact with the tube *f*, containing cold water, and is condensed, while the excess of air and the nitrogen escape into the atmosphere by the spaces at *f, g.* In half-an-hour a considerable quantity of water is collected at the knee, *e.*

This apparatus is a modification of that contrived by MM. Danger and Flandin, for the detection of arsenic. When arseniuretted hydrogen gas is burnt with this apparatus, solid arsenious acid is deposited in the tube, *c, o,* and a solution of arsenious acid collected at the knee, *e,* in the bent tube.

The method of separating vapours from incondensible gases, by means of the cold water tube, *f*, can often be advantageously employed by the practical chemist; as, for example, when digesting substances in a flask with aqua regia, alcohol, and other volatile solvents.

22d March, 1842,—*The* PRESIDENT *in the Chair.*

John Campbell, Esq. admitted a member.

The report of the publishing committee was taken into consideration, their recommendations adopted, and a committee appointed to carry them into effect.

The following communications were made:—

XV.—*Notice of Divi-divi.* *By* JOHN STENHOUSE, Ph.D.

THIS substance, by some called Divi-divi, by others Libi-divi, has of late years been imported into this country from Carthagena in considerable quantities. It is the pod of a leguminous shrub, which grows to the height of between twenty and thirty feet. Professor Balfour informs me that its botanical name is *Caesalpinia Coriaria.* It is a native of South America, and is noticed by Dr. M'Fadyen in his Flora of Jamaica, as occurring in that island. The pods of this shrub, which form the Divi-divi of commerce, are of a dark brown colour, nearly three inches long, and about half-an-inch broad. They are very much curled up as if they had been strongly dried; and contain a few small flatish seeds. The taste of Divi-divi is highly astringent and bitter. The astringent matter of the Divi-divi is contained only in the outer rind of the pod; the inner skin enclosing the seeds is white and nearly tasteless. The pods are often perforated with small holes, evidently the work of some insect. The aqueous solution of Divi-divi gives a copious precipitate with gelatine, and strikes a deep blue with per salts of iron. It contains a good deal of tannin, and also some gallic acid, accompanied by a great deal of mucilage. Crystals of gallic acid may easily be obtained from Divi-divi by precipitating the tannin it contains with solution of gelatine, evaporating to the consistence of an extract, and then treating it with alcohol. After allowing it to subside, the alcoholic solution is to be drawn off, the greater portion of the spirit recovered by distillation, and the residue is to be evaporated to dryness on the water bath. It is then to be introduced into a stoppered bottle, and repeatedly agitated with ether; almost the whole of the ether is to be distilled off, and the residue left to spontaneous evaporation. Abundance of reddish coloured crystals soon appear. They are to be purified by being repeatedly crystallized out of alcohol and water, and by digestion with animal charcoal. Lastly, by uniting them to oxide of lead, and decomposing the insoluble precipitate with sulphuretted hydrogen, they are rendered beautifully white. The crystals then exhibit the silky lustre of gallic acid, with which acid their re-actions with salts of iron and other re-agents completely correspond. When distilled, they yield abundance of pyrogallic acid. When dried at 212°F. and subjected to analysis,

I. 0.3034 gramme acid gave 0.550 carbonic acid and 0.1018 water.

II. 0.3052 gave 0.5505 carbonic acid and 0.1012 water.

	I.	II.	Calculated per cent.
C	50.12	49.87	7 C = 49.89
H	3.72	3.71	3 H = 3.49
O	46.16	46.42	5 O = 46.62
	100.00	100.00	100.00

These results approach very closely the calculated numbers of hydrated gallic acid given above.

In order to determine the atomic weight of the acid, I formed the basic gallate of lead by adding a solution of the acid obtained from the Divi-divi to an excess of boiling acetate of lead. It precipitated as a yellow, slightly crystalline powder, and was also dried at 212°F.

I. 0.706 of this salt gave 0.3325 lead, and 0.1802 oxide = 76.25 per cent. oxide of lead.

II. 0.887 salt gave 0.315 lead, and 0.340 oxide of lead = 76.58 per cent. oxide lead.

Now the bibasic gallate of lead $C^7 H O^3 + 2Pb O$ contains 76.69 per cent. oxide of lead; there can therefore be no doubt that it was the salt analysed, and that gallic acid therefore occurs to a considerable extent ready formed in Divi-divi.

As the tannin of nut galls yields pyrogallic acid when distilled, I was induced to try if the tannin of Divi-divi had the same property. I therefore precipitated a quantity of its tannin by slowly adding sulphuric acid to a saturated solution of Divi-divi. A very scanty dark brown precipitate fell, it was collected on a cloth filter, strongly compressed and washed with a little cold water to free it as much as possible from adhering sulphuric acid. When dried and subjected to distillation, it did not yield any trace of pyrogallic acid. It gave off scarcely any empyreumatic products, and left a very bulky charcoal.

The tannin of Divi-divi appears therefore essentially different from that of nut galls.

Mr. Harvey informs me, that, a few years ago, some calico printers endeavoured to employ Divi-divi as a substitute for galls, but the large quantity of mucilage it contained rendered it unfit for this purpose. It is at present employed pretty extensively in the tanning of leather, as the presence of mucilage is not injurious to that process. The price for which Divi-divi sells is about £20 per ton.

XVI.—*On Artificial Ultramarine. By* JOHN STENHOUSE, Ph.D.

TILL within the last twelve or fifteen years the only source of this beautiful pigment was the rare mineral, *lapis lazuli.* The price of the finest Ultramarine was then so high as five guineas the ounce. Since the mode of making it artificially has been discovered, however, its price has fallen to a few shillings the ounce. Artificial Ultramarine is now manufactured to a very considerable extent on the continent, but as far as I can learn, none has as yet been made in Great Britain. The chief French manufactories of Ultramarine are situated in Paris; and the two largest ones in Germany are those of Meissen in Saxony, and of Nuremberg in Franconia. Three kinds of Ultramarine occur in commerce, the blue, the green, and the yellow. The two first only are true Ultramarines, that is, sulphur compounds; the yellow is merely chromate of baryta.

Both native and artificial Ultramarine have been examined very carefully by several eminent chemists, who, however, have been unable to throw much light upon their true nature. Chemists have undoubtedly ascertained that Ultramarine always consists of silica, alumina, soda, sulphur, and a little oxide of iron, but no two specimens, either of the native or artificial Ultramarine, contain these ingredients in at all similar proportions. In fact the discrepances between the analyses are so great as to render it impossible to deduce from them any formula for the constitution of Ultramarine; if indeed it does possess any definite composition. The following are a few specimens of these analyses, and others equally discordant might easily be added.

	Lapis Lazuli. By CLEMENT AND DESORMES.	*Lapis Lazuli. By* VARRENTRAP.
Soda,	23.2	9.09
Alumina,	24.8	31.67
Silica,	35.8	45.50
Sulphur,	3.1	0.95
Carbonate of Lime,	3.1	3.52 Lime.
		0.86 Iron.
		0.42 Chlorine.
		5.89 Sulphuric Acid.
		0.12 Water.

	Parisian Artificial Ultramarine. By C. G. GMELIN.	Meissen Artificial Ultramarine. By VARRENTRAP.
Soda and Potash,	12.863	21.47
Lime,	1.546	1.75 Potash.
Alumina,	22.000	0.02
Silica,	47.306	23.30
Sulphuric Acid,	4.679	45.00
Resin, Sulphur, and Loss,	12.218	3.83
		0.00
		1.063 Iron.

The last chemist who has examined Ultramarine is Dr. Elsner, who has published a very elaborate paper upon it in the 23d number of Erdmann's Journal for 1841. The first part of Dr. Elsner's paper is historical, and contains an account of the accidental discovery of artificial Ultramarine by Tassart and Kuhlman in 1814, and of the labours of subsequent chemists. He then gives a detailed account of his own experiments, which have been very numerous, and from these he deduces the following conclusions:—1st, That the presence of about one per cent. of iron is indispensable to the production of Ultramarine; he supposes the iron to be in the state of sulphuret. 2d, That the green Ultramarine is first formed, and that as the heat is increased it passes by degrees into the blue. The cause of this change is, he affirms, that part of the sodium absorbs oxygen from the atmosphere, as the operation is conducted in only partially closed vessels, and combines with the silica, while the rest of the sodium passes into a higher degree of sulphurization. Green Ultramarine therefore, contains simple sulphurets and blue, polysulphurets.

Dr. Elsner's paper does not, however, furnish any details by which Ultramarine could be manufactured successfully on the great scale. Thus, for example, in regard to the necessary degree of heat, perhaps the most important circumstance in the process, he gives no directions whatever. We know, however, from other sources, that it should be a low red heat, as at much higher temperatures both native and artificial Ultramine soon become colourless. Dr. Elsner, indeed, does not affirm that he was able to procure Ultramarine in quantity of a uniformly good colour. In fact the process of Robiquet, published nearly ten years ago, is the best which scientific chemists possess, though undoubtedly, the manufacturers have greatly improved upon it. Robiquet's process consists in heating to low redness a mixture of one part porcelain clay, one and a half sulphur, and one and a half parts anhydrous carbonate of soda, either in an earthenware retort or covered crucible, so long as vapours are given off. When opened the crucible usually contains a spongy mass of a deep blue colour, containing more or less Ultramarine mixed with the excess of sulphur employed, and some unaltered clay and soda. The soluble matter is removed by washing, and the ultramarine separated from the other impurities by levigation. It is to be regretted, however, that the results of Robiquet's process are by no means uniform; one time it yields a good deal of Ultramarine of excellent quality, and perhaps, at the very next repetition of the process in circumstances apparently similar, very little Ultramarine is obtained, and that of an inferior quality.

The fabrication of Ultramarine is a subject which well deserves the attention of English chemical manufacturers, as it could be carried on with peculiar advantage in this country. The chief expense of the process is the fuel required, which can be purchased in Great Britain for less than half the money it would cost either in France or Germany.

MR. MORE read a *Notice on Galvanometers, as Measurers of Electric Currents.*

6th April, 1842,—*The* PRESIDENT *in the Chair.*

Dr. Hutcheson was admitted a Member.

On the motion of Mr. Liddell, it was resolved, that the printed Proceedings of the Society should, this session, be presented gratuitously to the members, and that in subsequent years the library subscription should be increased from 12s. 6d. to 15s. in order to meet the expense of publication. It was farther agreed, that the original and non-resident members should contribute 5s. each, per annum; and, in consideration of these increased contributions, each member should be entitled to a copy of the transactions when published.

The following communication was read:—

XVII.—*Comparative Experiments made with different Manures.* *By* JOHN WILSON, Esq.

A PIECE of three years' old pasture, of uniform quality, extending to two hundred falls, old Scotch measure, was divided into ten lots, of twenty falls each. These were treated as follows, and produced, respectively, the quantity of well-made hay placed opposite each of the lots in the table.

	Produce of Lot in lbs.	Rate of Produce per Acre, in lbs.	Increase of Produce per Acre.
Lot 1.—Left untouched,........	420	3360	—
„ 2.—Added 2½ barrels Irish Quick Lime,........	602	4816	1456
„ 3.—Added 20 cwt. Lime from Gas Works,........	651	5208	1848
„ 4.—Added 4½ cwt. Wood Charcoal Powder,........	665	5320	1960
„ 5.—Added 2 bushels Bone Dust,........	693	5544	2184
„ 6.—Added 18 lbs. Nitrate of Potash,........	742	5936	2576
„ 7.—Added 20 lbs. Nitrate of Soda,........	784	6272	2912
„ 8.—Added 2½ bolls Soot,........	819	6552	3192
„ 9.—Added 28 lbs. Sulphate of Ammonia,........	874	6776	3416
„ 10.—Added 100 gallons Ammoniacal Liquor, from Gas Works, at 5° of Twaddel's Hydrom.,	945	7560	4200

The value of each of the applications was precisely the same, viz., five shillings for each lot; or at the rate of £2 per acre. All the articles were applied at the same time—on the 15th April, 1841, and the grass cut and made into hay on the following month of July.

20th April, 1842,—*The* PRESIDENT *in the Chair.*

Dr. Stenhouse exhibited specimens of the Wood Coal of Germany, —Divi-divi, &c.

The following communications were read:—

XVIII.—*On the Nature and Cure of Blindness produced by Oil of Vitriol. By* ROBERT D. THOMSON, M.D.

AT the meeting of the British Association which met at Glasgow in 1840, the author proposed an operation, by which he considered that blindness, or opacity of the cornea, produced by the action of sulphuric acid, might be remedied. This view was grounded on the following considerations:—The basis of animal matter, according to the most recent researches of chemists, appears to be a substance termed protein, consisting of $C_{40}\ H_{31}\ N_5\ O_{12}$, which can be readily prepared from albumen, fibrin, &c., by solution in caustic alkali, and precipitation by acetic acid. This substance appears to be a base, and combines with acids. When sulphuric acid is brought in contact with it, a fine white substance is formed, which may be obtained in the state of a white powder by careful washing and drying. It may be conveniently produced by triturating the crystalline lens of the eye in a mortar along with sulphuric acid. This acid is termed *sulpho-proteic,* and its formula is $Pr + SO_3$.

The conjunctiva, the membrane which covers the cornea, or transparent part of the eye, contains as its basis *protein.* If we, therefore, bring sulphuric acid in contact with this membrane, *sulpho-proteic* acid is formed, and opacity of the transparent cornea takes place. This is the result when by accident, or intention, sulphuric acid falls or is thrown upon the person. It was a case where this corrosive liquid was thrown criminally at the head of a man that attracted the author's attention to the subject. He found, by making a series of experiments upon the eyes of dead animals, that when sulphuric acid is applied to the cornea, a layer of sulpho-proteic acid is produced, which may be removed by means of a sharp-edged knife; and that, even after dissecting off the first layer, a second application of the acid will produce a new layer of sulpho-proteic, and which may be excised or torn off in a similar manner; and in this way that the whole of the cornea may be successively divided into a series of layers corresponding in some degree with the natural structure of that membrane. This method presents, in short, an excellent mode of demonstrating anatomically the layers of the cornea. Having found that the opacity was completely removed, by the excision of the layer of sulpho-proteic acid, on the dead animal, it was conceived that the idea of performing the operation upon a living animal was justifiable. Accordingly, a dog was selected as the subject of experiment. It was properly secured on a table, and a muzzle was applied, so as to prevent it from using its teeth. It was considered also that it should be kept as steady as possible, in order to give a fair chance to the experiment. The end of a glass rod dipped in oil of vitriol was rubbed over the transparent part of the eye. White opacity was produced in a few seconds. The action was allowed to continue for two minutes, the eyelids being carefully kept aside. In order to prevent the acid from extending to the mucous membrane of the eye-lids, a piece of lint dipped in a solution of carbonate of soda was then applied to the eye, and the animal left at rest for five minutes. On removing the lint, the cornea presented a white appearance, and was obviously quite opaque. Having secured the eyelids, the conjunctiva was removed by means of a pair of scissors, assisted by a scalpel and forceps, and the denuded cornea was then scraped by means of the scalpel, until it appeared to be deprived of its white opacity. A slight degree of dullness remained, which appears to have proceeded from the exudation on the surface of the cornea, for in a day or two the perfect transparency of that membrane was restored, and the animal lived for many weeks with complete vision of the eye. Dr. Krauss of London, who assisted the author in the experiment, and to whom the dog belonged, satisfied himself that the eye which had been operated on, retained as perfect vision as that of the other eye, until the death of the animal some weeks afterwards from an accidental cause.

The author has been induced to give publicity to this successful experiment, because he considers that he has seen eyes which might have thus been restored to vision, if the operation had been performed *immediately after the receipt* of the injury. The animal did not appear to suffer pain, except when any fluid came in contact with the eye-lids.

XIX.—*On the Statical Relations of the Gases.* *By* JOHN JOSEPH GRIFFIN.

THE following Table is in part translated from a Table contained in the fourth edition of ROSE's *Handbuch der Analytichen Chemie.* Berlin, 1838. It is however modified in several particulars. The third, fourth, and fifth columns are new.

The plan of the Table is as follows:—

The first column contains the names of the gases, both elementary and compound, including, for facility of reference, the vaporisable elements, and also the non-volatile elements, Boron, Carbon, &c., with their *assumed* specific gravity, atomic measure, &c.

The second column exhibits the composition of the different gases in atoms, expressed in symbols. The value of the symbols is in all cases the same as is given by Berzelius.

The third column contains the atomic weights of the elements and compounds named in the two preceding columns. The atomic weights of the compounds are, of course, the sum of the atomic weights of their elements. The numbers used are those of Berzelius.

The fourth column shows the Atomic Measure of the gases. The mode of expression made use of here is new. It consists in employing a vulgar fraction, the *denominator* of which represents the sum of the atomic measures of the constituents of a gas, while the *numerator* shows the number of resulting volumes.—This method of expressing Atomic Measures seems to me to be much more exact and convenient than the method followed by many writers, of using small square diagrams for that purpose.—The atomic measure of a gas represents its combining proportion. It contains the number of volumes, the weight of which make up its atomic weight, (of course, in reference to some fixed standard). The atomic measure of a compound gas is not the volume *occupied* by its constituents, but the volume *produced* after combination.

The fifth column shows the specific gravity of the different gases, in reference to the specific gravity of oxygen gas taken as a standard; or it denotes the weight in grains of as much in bulk of each gas as would fill a vessel capable of holding 90.695 grains of atmospheric air, or 100.000 grains of oxygen gas.

The sixth column shows the specific gravity of many of these gases, in reference to another standard, namely, atmospheric air, taken equal to 1.0000. Such gases only are enumerated in this column as have actually been weighed, and the numbers quoted represent the result of the weighings. The blanks show what gases have never been weighed.

An examination of these two methods of indicating the specific gravities of gases, and a comparison of the numbers with those that indicate the atomic weights and atomic measures of the gases, show that great advantages would result from a more general adoption, by chemists, of the series of numbers contained in the fifth column. In the early days of chemistry, when only a few gases were known, it was natural to compare their densities with that of atmospheric air; but at present it would be much more convenient to take the density of oxygen gas as our standard, more especially when the density of this very gas forms, as it does in this Table, the basis of the system of atomic weights.

The particulars contained in columns 3, 4, and 5, are brought into calculations with the help of the following proportions:—If, of the atomic weight, the atomic measure, and the specific gravity of a gas, we know two terms, it is easy to find the third:—

Let *a. m.* = the atomic measure; *a. w.* = the atomic weight; and *sp. gr.* = the specific gravity, Then, To find the Specific Gravity of a gas, $\frac{a.\ w.}{a.\ m.} = sp.\ gr.$

To find the Atomic Weight of a gas, $a.\ w. = a.\ m. \times sp.\ gr.$

To find the Atomic Measure of a gas, $\frac{a.\ w.}{sp.\ gr.} = a.\ m.$

The seventh column of the Table shows the composition in volumes, of a single volume of every different gas. In respect to the elements, it shows also what relation a single volume of each bears to a single atom. Thus, one volume of Oxygen is seen to be equal to one atom; one volume of Arsenic to be equal to two atoms; one volume of Mercury to be equal to half an atom; and one volume of Sulphur to be equal to three atoms. In respect to the compound gases, it shows the proportions, both of their proximate and ultimate components. Thus, one volume of Hydrocyanic acid is seen to contain, as proximate constituents, half a volume of Cyanogen, and half a volume of Hydrogen, while, as ultimate constituents, it contains half a volume of Nitrogen, half a volume of Carbon, and half a volume of Hydrogen. It must be borne in mind, in examining the details of this column, that the symbols invariably signify ***volumes,*** and not *atoms,* and that the fractions are fractions of volumes and not of atoms.

Formulæ for determining the WEIGHT of a given MEASURE of any Gas.

1. *In reference to English Cubic Inches.*

Thermometer 60° F. Barometer 30 inches.

Multiply the specific gravity of the gas, as stated in column fifth of the Table, by its measure, expressed in cubic inches, and the product by 0.003418. The result is the weight of the gas expressed in imperial grains:

Let x be the number of cubic inches of gas, then,

$$\left.\begin{array}{c}\text{Absolute weight in grains}\\ \text{of } x \text{ cubic inches of gas.}\end{array}\right\} = \text{sp.gr.} \times x \times .003418.$$

Examples:—1. The weight of 100 cubic inches of oxygen gas is $100.000 \times 100 \times .003418 = 34.18$ grains.

2. The weight of 50 cubic inches of atmospheric air is $90.695 \times 50 \times .003418 = 15.4998$ grains.

2. *In reference to Cubic Centimeters.*

Thermometer 0° Centigrade. Barometer 0.76 meter.

Multiply the specific gravity of the gas, as given in column fifth of the Table by its measure, expressed in cubic centimeters, and the product by 0.0000143236. The result is the weight of the gas expressed in grammes.

$$\left.\begin{array}{c}\text{Absolute weight in grammes of}\\ x \text{ cubic centimeters of gas.}\end{array}\right\} = \text{sp.gr.} \times x \times .0000143236.$$

Examples:—1. The weight of 1000 cubic centimeters (= 1 Litre) of oxygen gas is 100.000 × 1000 × .0000143236 = 1.43236 grammes.

2. The weight of 500 cubic centimeters of nitrogen gas is 88.518 × 500 × .0000143236 = .63395 gramme.

3. *Proposed New Unit for Gas Measures.*

This unit is ***the bulk of a grain of oxygen gas***, taken when Fahrenheit's thermometer is at 60°, and the barometer at 30 inches. On the assumption that a ***cubic inch*** of oxygen gas weighs .3418 grain, the bulk of a ***grain*** of oxygen gas would be equal to 2.9257—nearly 3—cubic inches.

A gas jar containing 10 of these units, = 10 grains of oxygen gas, would contain 29.257—nearly 30—cubic inches.

A large receiver might contain 100 such units, = 100 grains oxygen gas, or 292.57—nearly 300—cubic inches; being a little more than an imperial gallon, which contains 277.274 cubic inches.

All these measures should be divided into 10ths and 100ths.

If the decimal weights and measures were preferred, then we might take for the unit of measurement, ***the bulk of one decigramme of oxygen gas*** (= 100 milligrammes = 1.5438 grains); for the second measure, the bulk of a *gramme* of oxygen gas (= 15.438 grains = 100 centigrammes); and for the third measure, the bulk of a *decagramme* of oxygen gas (= 154.38 grains = 100 decigrammes). In this case, the temperature at which the gas is measured should be 0° Cent., and the barometer pressure 0.76 meter.

These measures would be about ½ larger than the proposed English grain measures, the relation of the milligramme to the 100th of a grain being that of .15438 to 1.0000.

All the gramme measures should, like the grain measures, be divided into 10ths and 100ths.

Advantages peculiar to this Standard.

The great advantage presented by this method of graduating Gas Measures, is, that it shows, distinctly and readily, the absolute weight (either in grains or grammes according to the standard adopted) of any quantity of any gas submitted to trial. As all the vessels are graduated to 100 degrees, and as the atomic weight and the specific gravity of oxygen gas are both fixed at 100.000, it follows that, in order to estimate the absolute weight of a measured quantity of a gas, all we have to do is to multiply the degree which marks the measure by the number which indicates the specific gravity. There is, consequently, only a single multiplication to perform, whereas, in all the cases cited above, there are two multiplications required, neither of which can be avoided. The only precaution necessary to be taken in making the calculations, is to place the decimal point in the proper place. It is scarcely necessary to add, that the multiplications can be facilitated by the help of logarithms.

NAME OF GAS.	Composition in Atoms.	Atomic Weight. — Oxygen = 100.000.	Atomic Measure.	Specific Gravity. — Oxygen Gas = 100.000.	OBSERVED Specific Gravity. — Air = 1.0.	Composition in Volumes, of ONE VOLUME of the Compound Gas.
Air, ...				90.695	1.0000	
Alcohol, . . .	C^2H^6+O	290.315	$\frac{2}{6}$			$CH^3\frac{1}{2}O$
Ether, Hydrate,	$C^4H^{10}O + H^2O$	580.630	$\frac{4}{4}$	145.1575	1.6133	$\frac{1}{2}C^2H^5O\frac{1}{2} + \frac{1}{2}HO\frac{1}{2}$
Ammonia, . .	NH^3 . .	107.238	$\frac{2}{4}$	53.619	0.5967	$\frac{1}{2}N+\frac{3}{2}H$
— 2 *atoms*, . .	N^2H^6 .	214.476	$\frac{4}{8}$			
Antimony, . .	Sb . .	806.452	$\frac{1}{2}$			
— *double atom*, .	Sb^2 . .	1612.904	1	1612.904		Sb
— Terchloride, .	Sb^2Cl^6 .	2940.854	$\frac{4}{7}$	735.2135	7.8	$\frac{1}{4}Sb+\frac{6}{4}Cl$
Arsenic, . . .	As . .	470.042	$\frac{1}{2}$			
— *double atom*, .	As^2 . .	940.084	1	940.084	10.65	As
— Terchloride, .	As^2Cl^6 .	2268.034	$\frac{4}{7}$	567.0085	6.3006	$\frac{1}{4}As+\frac{6}{4}Cl$
— Teriodide, .	As^2I^6 .	5678.584	$\frac{4}{7}$	1419.646	16.1	$\frac{1}{4}As+\frac{6}{4}I$
Arsenious Acid, .	As^2O^3 .	1240.084	$\frac{1}{4}$	1240.084	13.85	As+3O
Boron, ...	B . . .	136.204	1	136.204		B
— Chloride, .	BCl^6 . .	1464.154	$\frac{4}{7}$	366.0385	3.942	$\frac{1}{4}B+\frac{6}{4}Cl$
— Fluoride, .	BF^6 . .	837.604	$\frac{4}{7}$	209.401	2.3124	$\frac{1}{4}B+\frac{6}{4}F$
Bromine, . . .	Br . . .	489.153	1	489.153	5.54	Br
Carbon, . . .	C . . .	76.438	1	76.438		C
— Oxide, . .	CO . .	176.438	$\frac{2}{2}$	88.219	0.9409	$\frac{1}{2}C+\frac{1}{2}O$
— Sulphuret, .	CS^2 . .	478.768	1·$\frac{2}{66}$	239.384	2.6447	$\frac{2}{6}S+\frac{2}{6}C$
— — 3 *atoms*,	C^3S^6 . .	1436.304	$\frac{6}{5}$			
Carbonic Acid, .	CO^2 . .	276.438	$\frac{2}{3}$	138.219	1.524	$\frac{1}{2}C+O$
Chlorine, . . .	Cl . . .	221.325	1	221.325	2.47	Cl
Chromium, . .	Cr . . .	351.815	1	351.815		Cr
— Oxychloride,	CrO^2Cl^2	994.465	$\frac{2}{5}$			
Chlorochromic Acid,	$CrCl^6 + 2CrO^3$	2983.395	$\frac{6}{15}$	497.2325	5.9	$Cr\frac{1}{2}$ OCl
Cyanogen, . .	C^2N^2 . .	329.912	$\frac{2}{4}$	164.956	1.8064	C+N
Ether, ...	$C^4H^{10}O$		$\frac{2}{15}$			$C^2H^5O\frac{1}{2}$
Etherine, Hydrate,	$4CH^2 + H^2O$	468.150	$\frac{2}{6}$	234.075	2.586	$2CH^2+HO\frac{1}{2}$
Ethyl, Oxide, .	$C^4H^{10} + O$		$\frac{2}{3}$			$C^2H^5+O\frac{1}{2}$
Etherine, Olefiant gas,	CH^2 . .	88.918	$\frac{1}{3}$	88.918	0.9852	CH^2
Fluorine, . . .	F . . .	116.900	1	116.900		F
Hydrogen, . .	H . . .	6.2398	1	6.2398	0.0688	H
— Antimoniuret^d	H^6Sb^2 .	1650.343	$\frac{4}{7}$	412.586		$\frac{1}{4}Sb+\frac{6}{4}H$
— Arseniuretted,	H^6As^2 .	977.523	$\frac{4}{7}$	244.381	2.695	$\frac{1}{4}As+\frac{6}{4}H$
— Carburetted, Marsh Gas,	H^4C . .	101.397	$\frac{2}{5}$	50.6985	0.556	$\frac{1}{2}C+2H$
— Carburet, .	H^4C^2 .	177.835	$\frac{1}{6}$	177.835	1.8	2C+4H
— Phosphuretted,	H^6P^2 .	429.725	$\frac{4}{7}$	107.4312	1.151	$\frac{1}{4}P+\frac{6}{4}H$
— Sulphuretted,	H^2S . .	213.645	2·$\frac{2}{33}$	106.8223	1.1912	$\frac{1}{6}S+H$
— — 3 *atoms*,	H^6S^3 .	640.934	$\frac{6}{7}$			
Hydrobromic Acid,	H^2Br^2 .	990.786	$\frac{4}{4}$	247.6965		$\frac{1}{2}Br+\frac{1}{2}H$
Hydrochloric Acid,	H^2Cl^2 .	455.130	$\frac{4}{4}$	113.7825	1.2474	$\frac{1}{2}Cl+\frac{1}{2}H$
Hydrocyanic Acid,	$H^2+N^2C^2$	342.392	$\frac{4}{4}$	85.598	0.9476	$\frac{1}{2}CN+\frac{1}{2}H$
Hydrofluoric Acid,	H^2F^2 .	246.280	$\frac{4}{4}$	61.570		$\frac{1}{2}F+\frac{1}{2}H$
Hydriodic Acid, .	H^2I^2 . .	1591.980	$\frac{4}{4}$	397.995	4.44	$\frac{1}{2}I+\frac{1}{2}H$
Iodine, . . .	I . . .	789.750	1	789.750	8.716	I
Mercury, . . .	Hg . .	1265.822	2			
— ½ *atom*, . .	Hg½ . .	632.911	1	632.911	7.03	Hg
— Protobromide,	Hg^2Br^2 .	3509.950	$\frac{4}{6}$	877.4875	10.11	$Hg+\frac{1}{2}Br$
— Perbromide,	$HgBr^2$.	2244.128	$\frac{2}{4}$	1122.064	12.16	Hg+Br

NAME OF GAS.	Composition in Atoms.	Atomic Weight. — Oxygen = 100.000.	Atomic Measure.	Specific Gravity. — Oxygen Gas = 100.000.	OBSERVED Specific Gravity. — Air = 1.0.	Composition in Volumes, of ONE VOLUME of the Compound Gas.
Mr. Protochloride,	Hg^2Cl^2 .	2974.294	$\frac{4}{6}$	743.5735	8.35	$Hg+\frac{1}{2}Cl$
— Perchloride,	$HgCl^2$.	1708.472	$\frac{2}{4}$	854.236	9.8	$Hg+Cl$
— Periodide, .	HgI^2 . .	2845.322	$\frac{2}{4}$	1422.661	16.2	$Hg+I$
— Sulphuret, .	HgS . .	1466.987	2·$\frac{3}{3}$ 3	488.9957	5.95	$\frac{6}{9}Hg+\frac{1}{9}S$
— — 3 *atoms*,	Hg^3S^3 .	4400.961	$\frac{9}{7}$			
Nitrogen, . . .	N . . .	88.518	1	88.518	0.976	N
Nitrous Oxide, .	N^2O . .	277.036	$\frac{2}{3}$	138.518	1.5204	$N+\frac{1}{2}O$
Nitric Oxide, .	NO . .	188.518	$\frac{2}{2}$	94.259	1.0388	$\frac{1}{2}N+\frac{1}{2}O$
Oxygen, . . .	O . . .	100.000	1	100.000	1.1026	O
Phosgen Gas, .	$CO+Cl^2$	619.088	$\frac{2}{4}$	309.544		$C\frac{1}{2}O\frac{1}{2}+Cl$
Phosphorus, . .	P . . .	196.143	$\frac{1}{2}$			
— *double atom*,	P^2 . . .	392.286	1	392.286	4.58	P
— Protochloride,	P^2Cl^6 .	1720.236	$\frac{4}{7}$	430.059	4.875	$\frac{1}{4}P+\frac{6}{4}Cl$
— Perchloride,	P^2Cl^{10} .	2605.536	$\frac{6}{11}$	434.256	4.85	$\frac{1}{6}P+\frac{10}{6}Cl$
Selenium, . . .	Se . . .	494.583	2			
— $\frac{1}{2}$ *atom*, . .	$Se\frac{1}{2}$ . .	247.2915	1	247.2915		Se
Selenious Acid, .	SeO^2 . .	694.583	$\frac{2}{4}$	347.2915	4.03	Se + O
Silicon, ...	Si . . .	277.312	1	277.312		Si
— Chloride, .	$SiCl^6$.	1605.262	$\frac{3}{7}$	535.0873	5.939	$\frac{1}{3}Si+2Cl$
— Fluoride, .	SiF^6 . .	978.712	$\frac{3}{7}$	326.2373	3.6	$\frac{1}{3}Si+2F$
Sulphur, . . .	S . . .	201.165	$\frac{1}{3}$			
— 3 *atoms*, . .	S^3 . . .	603.495	1	603.495	6.9	S
— Chloride, .	SCl . .	422.490	1·$\frac{1}{3}$ 3	422.490	4.7	$\frac{1}{3}S+Cl$
— — 3 *atoms*,	S^3Cl^3 .	1267.470	$\frac{3}{4}$			
Sulphurous Acid,	SO^2 . .	401.165	2 $\frac{2}{3}$ 3	200.5825	2.247	$\frac{1}{6}S+O$
— 3 *atoms*, . .	S^3O^6 .	1203.495	$\frac{6}{7}$			
Sulphuric Acid, *dry*,	SO^3 . .	501.165	3·$\frac{2}{3}$ 3	250.5825	3.01	$\frac{1}{6}S+\frac{9}{6}O$
— 3 *atoms*, . .	S^3O^9 .	1503.495	$\frac{6}{10}$			
Tin, ...	Sn . . .	735.296	1	735.296		Sn
— Chloride, .	$SnCl^4$.	1620.596	$\frac{2}{5}$	810.298	9.1997	$\frac{1}{2}Sn+2Cl$
Titanium, . . .	Ti . . .	303.662	1	303.662		Ti
— Chloride, .	$TiCl^4$.	1188.962	$\frac{2}{5}$	594.481	6.836	$\frac{1}{2}Ti+2Cl$
Water, . . .	H^2O . .	112.480	$\frac{2}{3}$	56.240	0.6235	$H+\frac{1}{2}O$

BOOKS

ADDED TO

THE SOCIETY'S LIBRARY IN THE YEARS 1840, 41, 42.

PERIODICAL PUBLICATIONS.

Annales des Mines, tomes 17 to 20, for 1840, 41. *Continued once in two months.*

Annales des Ponts et Chaussées.

1840, Mémoires 2 tom. Ordonnances. 1 tom.
1841, ——— 2 tom. ——— 1 tom.
Continued once in two months.

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Annales des Sciences Naturelles. *Continued monthly from January*, 1843.

Annals of Natural History. *Continued monthly from January*, 1843.

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——————— 20te ——— 1840.

Berzelius, Rapport Annuel sur les Progrès de la Chimie, 1e Année, 1841, 2e Année, 1842. *Continued annually.*

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Jameson's Edinburgh Journal of Science, vols. 28—33, for 1840—42. *Continued quarterly.*

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Reports of the British Association for the Advancement of Science. *Continued annually.*

Vol. 1. York 1831,	Vol. 4. Dublin 1835.	Vol. 7. Newcastle 1838.
Oxford 1832.	5. Bristol 1836.	8. Birmingham 1839.
2. Cambridge 1833.	6. Liverpool 1837.	9. Glasgow 1840.
3. Edinburgh 1834.		

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Sturgeon's Annals of Electricity, vols. 5, 6, 7, 1841.
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——— on the Nature, &c., of Steam, and on Steam Navigation, 1841.
Smee's (Alfred) Elements of Electro-Metallurgy, 1841.
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Whewell's (Rev. W.) History of the Inductive Sciences, 3 vols. 1837.
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BELL AND BAIN, PRINTERS, GLASGOW.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTY-FIRST SESSION, 1842-43.

CONTENTS.

2d November, 1842,—*The* President *in the Chair.*

Dr. Balfour alluded to some experiments recently made, which showed the innocuous nature of liquid muriatic acid applied to the roots of plants. He exhibited specimens of cocoa nuts in various stages of vegetation, and a portion of pith used, when cut into thin slices, for making rice paper.

The following paper was read:—

XX.—*Notice of some New Minerals. By* Thomas Thomson, M.D., F.R.S., L. & E., M.R.I.A., *Regius Professor of Chemistry.*

One of the most common and important minerals is felspar, which constitutes the principal constituent in granite and gneiss, and, together with hornblende, forms the rocks so prevalent in this part of Scotland,—I mean greenstone and basalt. Felspar is a double salt, being composed of three atoms of tersilicate of alumina, and one atom of tersilicate of potash. Sometimes the potash is replaced by soda. The mineral, in that case, is distinguished by the name of *albite*, and differs in the shape of its crystals.

Three of the minerals which I mean to notice at present, are connected with felspar, though they differ from it in their composition.

1. *Erythrite.*—The first species which I shall mention, is *erythrite.* It occurs rather abundantly in the Kilpatrick hills, and also in the amygdaloid on the south side of the Clyde, near Bishoptown. I do not know who first noticed it, but it was brought to me some years ago, as a new mineral, by Mr. Clachers, a mineral dealer in Old Kilpatrick. I call it *erythrite* on account of the flesh-red colour which distinguishes all the specimens which I have seen.

Its specific gravity is about 2·541, which agrees with that of common felspar; and its hardness is about the same as that of felspar. The texture is compact, or at least not sensibly foliated, and I have never seen a specimen of it in crystals. It is composed of

Silica, ...	67·90
Alumina, ...	18·00
Peroxide of iron, . .	2·70
Lime, ...	1·00
Magnesia, . . .	3·25
Potash, ...	7·50
Water, ...	1·00
	101·35

$$7\,(AlS^3) + Mg.\ S^3 + KS^3.$$

So that it differs from felspar by one half of the potash being replaced by magnesia.

2. *Perthite.*—The next mineral I have to notice, I distinguish by the name of Perthite. It was sent me by Mr. Wilson, a surgeon in Perth, a township of Upper Canada. Hence the name by which I have distinguished it. It is very much connected with felspar in appearance, and was sent as a variety of that mineral.

The colour of the specimen sent me is white. It consists of a mass of crystals so united together as to form a kind of tesselated pavement. The crystals are obviously four-sided prisms, apparently rectangular, but not susceptible of measurement, because they cannot be isolated.

The lustre is vitreous; the hardness is rather less than that of felspar; but the specific gravity, which is 2·586, is identical with some of the varieties of that mineral.

The constituents were found to be

Silica, ...	76
Alumina, ...	11·75
Magnesia, ...	11·00
Protoxide of iron, . .	0·225
Moisture, ...	0·65
	99·625

From this analysis, it is evident that it differs essentially from felspar. The quantity of silica is much greater, and the potash is entirely replaced by magnesia. Its constitution may be represented by the formula 6 (AlS^4) + 5 $(Mg.\ S^4)$. It is a quatersilicate, while felspar is a tersilicate. Could it be procured in sufficient quantity, it would be an excellent material for the manufacture of porcelain.

3. *Peristerite.**—The next mineral which I have to mention, was

* From περιστερα a pigeon, the colours resembling a pigeon's neck.

sent me also from Perth, in Upper Canada, by Mr. Wilson, and also by Dr. Holmes of Montreal, under the name of *iridescent felspar;* but neither its characters, nor its composition correspond with that appellation.

The specimens were amorphous masses, and had the appearance of having constituted part of a rock blasted by gunpowder.

It is light brownish-red, and exhibits a play of colours chiefly blue on the surface. It is translucent on the edges. The lustre is vitreous, and the texture imperfectly foliated. Its hardness is only 3·75, which is a good deal less than that of felspar.

Its specific gravity is 2·568.

Before the blow-pipe it becomes white, but does not melt. With carbonate of soda it melts into a green coloured bead; and, on adding nitre, the colour becomes red; with borax, it fuses into a colourless bead.

Its constituents were found to be—

Silica, ...	72·35
Alumina, ...	7·60
Potash, ...	15·06
Lime, ...	1.35
Magnesia, ...	1·00
Oxides of iron and manganese,	1·25
Moisture, ...	0·50
	99·11

The silica is much greater than in felspar, and the alumina much less, while the proportion of potash is nearly the same. If we were to consider the lime and magnesia, and the oxides of iron and magnesia, as accidental bodies united to silica, in the same ratio as the alumina and the potash, the constitution of the mineral might be represented by $4\ (AlS^5) + 3\ (KS^5)$. If the lime and magnesia be essential constituents, the formula will be $AlS^5 + (\frac{6}{8}\ K + \frac{1}{8}\ cal. + \frac{1}{8}\ Mg.)\ S^5$.

4. *Silicite.*—The fourth mineral which I shall notice, I have distinguished by the name of *silicite,* from the great resemblance which it has to quartz, in its external aspect, though it differs entirely from that mineral in its constitution. It occurs in a basaltic rock in the county of Antrim, and was given me by Mr. Doran, an Irish mineral dealer.

The colour is white, with a shade of yellow, the texture foliated, and the fracture small conchoidal. Its lustre is vitreous, its hardness nearly the same as that of quartz, and its specific gravity 2.666, or nearly the same as that of rock crystal.

With carbonate of soda, it fuses into an opaque bead, and with borax, into a transparent colourless bead. Its constituents are,

Silica, ...	54·8
Alumina, ...	28·4
Protoxide of iron, . .	4·0
Lime, ...	12·4
Water, ...	0·64
	100·24

If we suppose the oxide of iron to be combined with alumina, and to be only accidentally present, the constitution of silicite will be 7 (AlS^2) + 2 (Cal. S).

It is a double anhydrous aluminous silicate. It differs from fuller's earth by containing 2 (Cal. S) instead of 2 Aq.

5. *Gymnite.*—To the fifth mineral species which I mean to notice at present, I have given the name of *gymnite,* because its locality is the Bare hills west of Baltimore. I got the specimen in my collection from Mr. Alger of Boston, well known for his and Mr. Jackson's excellent geological description of Nova Scotia.

The mineral was in amorphous pieces, having a very pale and dirty orange colour. It is translucent on the edges; the lustre is resinous. It is very tough, and difficult to break. This makes it difficult to determine the hardness; but it is softer than felspar. The specific gravity is 2·2165.

When held in the flame of a spirit lamp, it becomes dark brown; with soda it fuses into a white opaque bead; with borax, into a colourless bead; with nitrate of cobalt it assumes a rose red colour.

Being subjected to analysis, its constituents were found to be

Silica, ...	40·16
Magnesia, ...	36·00
Water, ...	21·60
Alumina, with trace of iron,	1·16
Lime, ...	0·80
	99·72

It is therefore composed of silica, magnesia, and water, and its constitution may be represented by the formula 2 (MgS) + MgS + 4 Aq.

6. *Baltimorite.*—For the next mineral species which I mean to notice, I am also indebted to Mr. Alger. The specimen was labelled *asbestus with chrome,* and the locality, Baltimore. On this account, I have given the species the name of Baltimorite.

The colour is greyish green. The mineral is composed of longitudinal fibres, adhering to each other, and has a considerable resemblance to asbestus. The lustre is silky. The mineral is opaque; but when very thin, it is translucent on the edges. It is a very little softer than calcareous spar. It does not fuse before the blowpipe, but assumes a brown colour; with soda, melts into an opaque, and with borax, into a transparent bead. Its constituents are

Silica, ...	40·95
Magnesia, ...	34·70
Protoxide of iron, . .	10·05
Alumina, . . .	1·50
Water, ...	12·60
	99·8

Its constitution may be represented by the formula, 14 (MgS) + 3 ($\frac{3}{4}f + \frac{1}{4}$ Al) S^2 + 11 Aq.

Asbestus contains more silica, and a good deal of lime, which is wanting in baltimorite. Asbestus, in fact, is merely a variety of pyroxene.

7. For the next mineral, which, from its constitution, I call *subsesquisulphate of alumina*, I am also indebted to Mr. Alger. The locality is South Peru.

It is a soft opaque mineral, composed of silky fibres adhering to each other. The colour is white, but there is a reddish-yellow tint which partially pervades the specimens, owing, obviously, to a little foreign matter with which they are stained. The taste is acid and sweet, like that of alum. The specific gravity is 1·584. It is soluble in water. The constituents are

Sulphuric acid, . .	32·95
Alumina, ...	22·55
Sulphate of soda, . .	6·50
Water, ...	39·20
	101·2

obviously

1 atom sulphuric acid, .	5
1½ atom alumina, . .	3·375
1 atom sulphate of soda, .	9·0
5 atoms water, . .	5·625
	23

The sulphate of soda exists in a greater proportion than sulphate of potash or of ammonia does in our alum. It is curious that in South America, soda almost universally replaces the potash which occurs in other parts of the world. Instead of saltpetre, so abundant in India, and even in Europe, we have nitrate of soda in Peru; and, instead of potash alum, we find, in Buenos Ayres, and other districts of South America, soda alum, deposited in amygdaloidal cavities in a kind of shale.

8. Messrs. Alger and Jackson gave the name of *acadialite* to a variety of chabasite which they found in Nova Scotia, and specimens

of which Mr. Alger was kind enough to send to me. The colour of the mineral is yellow, and it has the crystalline shape, and the characters of chabasite so completely, that it would be considered as a mere variety of that mineral, were it not that the constituents do not quite agree. The specific gravity of acadialite is 2·0202, and its constituents,

Silica, ...	52·4
Alumina, ...	12·4
Lime, ...	11·6
Peroxide of iron, . .	2·4
Water, ...	21·6
	100·4

The proportion of alumina in chabasite is greater than in acadialite. If this difference be constant, acadialite must be considered as a new species. Its constitution, and that of chabasite, may be represented by the formulas,

Acadialite, $2\,(AlS^3) + Cal.\ S^2 + 6\ Aq.$

Chabasite, $3\,(AlS^2) + Cal.\ S^3 + 6\ Aq.$

9. *Prasilite.*—To the next mineral species which I shall mention, I have given the name of *prasilite*, from the green colour by which the only specimen which I have seen is characterized. It is found in the Kilpatrick hills, and was brought to me some years ago by a gentleman while attending my class. He had picked up the specimen, and brought it that I might tell him its name. On looking at and examining its hardness and texture, I pronounced it to be sulphate of lime, tinged by an admixture of epidote; but upon examining it chemically, I soon discovered that the opinion formed from its external characters, was erroneous.

The colour is dark leek green, and the hardness not more than 1·; for it does not scratch selenite. It is opaque, and has a specific gravity of 2·311 which comes near to that of selenite. It may be crumbled to powder between the fingers. It is composed of fibres very loosely adhering together. When heated to redness, it gives out 18 per cent. of water, assumes a light yellow colour, and becomes much harder. Being subjected to analysis, its constituents were found,

Water, ...	18·00
Silica, ...	38·55
Magnesia, ...	15·55
Lime, ...	2·55
Peroxide of iron, . .	14·90
Oxide of magnesia, . .	1·50
Alumina, ...	5·65
	96·70

The loss, amounting to 3 per cent., was probably an alkali. Prasilite is obviously a triple sesquisilicate. Its constitution may be represented by the formula, 8 $(MgS^{1\frac{1}{2}})$ + 4 $(f\,S^{1\frac{1}{2}})$ + 3 $(AlS^{1\frac{1}{2}})$ + 18 Aq.

10. The next mineral which I shall notice is one which occurs in the beds of iron ore at Franklin in New Jersey, and was first noticed by Messrs. Keating and Vanuxen about the year 1822 under the name of Jeffersonite. Keating made an analysis of it, the result of which induced me to place it among the magnesian minerals, and intimate in connection with pyroxene and amphibole. But having got a specimen of it through the kindness of Dr. Torrey of New York, I subjected it to a new analysis. The result was so different from Mr. Keating's, that it became evident that the position which I had assigned it was a wrong one, and that in reality it was a quadruple salt, consisting of silica united to the four bases—lime, alumina, iron, and magnesia.

The colour of Jeffersonite is dark olive green, passing into brown. It is foliated, and according to Keating may be cleaved in various directions. The specimen in my possession is an imperfect four sided prism; but the faces are not smooth enough to admit of measurement.

The lustre is resinous and almost semi-metallic; the streak is gray, and the powder light green. It is rather harder than fluor spar, though softer than apatite. The specific gravity is 3·51. Before the blowpipe it fuses readily into a dark coloured globule. Its constituents are

Silica, ...	44·50
Lime, ...	22·15
Alumina, ...	14·55
Protoxide of iron, . .	12·30
Magnesia, ...	4·00
Moisture, ...	1·85
	99·35

The constitution may be represented by the formula, 4 (Cal.S) + 4 (AlS) + 2 $(f\,S^2)$ + Mg S^2 so that it differs essentially in its composition from both pyroxene and amphibole.

16th November, 1842,—*The* PRESIDENT *in the Chair.*

Mr. Liddell, the Treasurer, presented his account, exhibiting an expenditure of £33, and a balance of £60 in banker's hands. The Librarian also brought forward his account, which showed the receipt of £50 for the library fund, and a balance of £15 in hand.

The following gentlemen were elected members of the society:—Dr. Hugh Colquhoun, Dr. Alexander Mitchell, Mr. Duncan Anderson, Mr. George Thomson, Mining Engineer.

The members of the Society then proceeded to ballot for Office-Bearers, when the following were elected for the session 1842-43:—

Office-Bearers.

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VICE-PRESIDENT,........WALTER CRUM.	SECRETARY,.............ALEXANDER HASTIE.
TREASURER,...............ANDREW LIDDELL.	LIBRARIAN,.............THOMAS DAWSON.

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Conveners of Sections.

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CONVENER,—WILLIAM MURRAY.
SUB-CONVENERS,—JAMES SMITH; ALEXANDER WATT.

Section B.—Chemistry, Mineralogy, and Geology.

CONVENER,—JOHN STENHOUSE, Ph. D.
SUB-CONVENERS,—ALEXANDER HARVEY; R. D. THOMSON, M.D.

Section C.—Physics, including Mechanics and Engineering.

CONVENER,—PROFESSOR GORDON.
SUB-CONVENERS,—F. PENNY, Ph. D.; JAMES BUCHANAN.

Section D.—Physiology and Natural History.

CONVENER,—J. H. BALFOUR, M.D.
SUB-CONVENERS,—A. ANDERSON, M.D.; J. FINDLAY, M.D.

30*th November,* 1842,—*The* PRESIDENT *in the Chair.*

Messrs. James Hill, William Spens, David Wharton, Robert B. Finlay, and James Couper, were admitted Members.

Mr. James Thomson, C.E., presented two Numbers of the Transactions of the Society of Arts of Edinburgh, in exchange for the Proceedings of the Philosophical Society.

Dr. Stenhouse read a communication *On Astringent Substances,* to be inserted in the Transactions of the Chemical Society of London.

The following Report was then read:—

XXI.—*Notice of some recent additions to Chemistry.*

THERE is no object in nature to which the attention of all deserves to be more closely directed than the atmosphere, if we were only to reflect that its absence for a few minutes would destroy all animal existence. Yet, strange as it may appear, the composition of common air is not even yet satisfactorily determined, in the opinion of all chemists. According to Dumas, the atmosphere consists of (Ann. de Chim. iii. 267.)

	By Weight.
Oxygen, ...	23.
Azote, ...	77.

And dividing these numbers by what he has found to be the specific gravities of the gases, he deduces the composition in bulk to be

$$\frac{23}{1{\cdot}1057} = 20{\cdot}80 \text{ Oxygen}, + \frac{77}{972} = 79{\cdot}22 \text{ Azote}.$$

Calculation, however, shows that the specific gravity of oxygen, according to his data, ought to be 1·1066 or 1·1067; and we believe Dumas considers that the true specific gravity cannot be under 1·107.

Dumas has lately published some experiments made at Copenhagen, on air taken from the surface of the ocean, where the ratios of the gases vary considerably from these data, as follows:—

	By Weight.	By Bulk. Sp. Gr. 1·1111.	By Bulk. Sp. Gr. 1·1067.
Oxygen, ...	22·58	20·3	20·40
Azote, ...	77·42	79·7	79·60

It deserves remark, that the mean of six experiments out of ten, made by Dr. Thos. Thomson, (First Principles, I. 98.) gave for the composition of air at Glasgow, by bulk—

Oxygen, . . . 20·42 Azote, . . . 79·58

This remarkable coincidence between the composition of the air at the sea, where vegetation is absent, and of that in the oxygen consuming city, perhaps deserves more attention than has yet been paid to it.

In connection with experiments upon pure air, the trials of Leblanc upon vitiated atmospheres are of high interest. The quantity of carbonic acid in the atmosphere in the normal state has been shown by the Saussures to vary from 3 to 6 parts in 10000. Leblanc (Ann. de Chim. v. 223.) has examined the quantity in crowded rooms, theatres, cities, &c. In the hospital La Pitie, the air of one of the wards containing 54 patients, afforded $\frac{3}{1000}$ of CO_2, or 5 times more than that of normal air. Under similar circumstances, at the Salpetriere, the quantity was $\frac{8}{1000}$. In Dumas' class-room, after a lecture of an hour and a half, where 900 persons were present, the carbonic acid amounted to 1 per cent., and the same quantity of oxygen had disappeared. From other experiments, he considers this a maximum quantity for safety, and strongly recommends a better ventilation when so much carbonic acid is present. This result agrees with experiments made in this country. When the atmosphere is deteriorated by burning charcoal, he has seen death produced when 3 per cent. of carbonic acid was present in the atmosphere. In all such cases of death from stoves, he has found carbonic oxide in the air, and he attributes a deleterious effect to the agency of this gas. He has observed 1 per cent. of this gas to destroy an animal in two minutes, which is at variance with the statement of Nysten. This observation explains many of the inconsistencies which appeared some years ago in the evidence of some London chemists respecting the influence of Joyce's stoves. It is quite obvious that their structure was dangerous. Leblanc found that a candle was extinguished in air containing 4½ or 6 per cent. of carbonic acid. In such an atmosphere life may be kept up for some time, but respiration is oppressive, and the animal is affected with very great uneasiness. Air expired from the lungs contains about 4 per cent. of carbonic acid, and hence this atmosphere is noxious. Even 3 per cent. in the atmosphere killed birds, and yet we have seen statements which affirmed that upwards of 3 per cent. had been detected in the London theatres. All these facts are pregnant with importance in reference to health. Our miners may not be suffocated by fire-damp explosions, but we should remember that their constitutions may be poisoned by the respiration of tainted atmospheres.

No one can have failed to remark the immense loss of illuminating gases sustained in the iron works of this country. We are not aware of any experiments which have been made upon their composition. But in Germany and France, where fuel is more scarce than in this country, economy has induced chemists to examine the nature of the loss in such circumstances. According to Ebelmen, (Ann. de Chim. v. 153.) in furnaces where charcoal is used, the gases at the mouth of the furnace consist of 13 per cent. carbonic acid, 23½ carbonic oxide, 6 per cent. hydrogen, and 58 azote. As we descend in the furnace, the carbonic acid and hydrogen diminish, till we arrive at the widest part, where there is no carbonic acid, and only 2 per cent. hydrogen. The carbonic oxide and azote, however, increase in descending, and amount in the same part of the furnace to 35 per cent. of the former, and 63 of the latter. It would appear that when the air is blown into the furnace, it is first converted into carbonic acid, and then rapidly into carbonic oxide, thus rendering latent an immense quantity of heat, and that the heat of the hot blast furnace has its efficacy limited to the lower part of the furnace. Dr. Bunsen, who made some important observations on this subject in 1839, (Poggendorff, Ann. xxxvi. 198.) showed that 50 to 75 per cent. of the combustible materials are lost in the form of carbonic oxide; that it would be impossible to use the waste gases with cold air for the smelting of iron; but that they might be employed, if collected at the temperature at which they exist when evolved, in conjunction with the hot blast.

The use of gases as illuminating agents is so important, that every method of obtaining them by economical means deserves attention. The employment of pure oxygen is daily becoming more extended. Mr. Balmain has lately applied (L' Institut. 458.) the well-known method of obtaining oxygen by the action of sulphuric acid on bichromate of potash, in organic chemistry, to the preparation of oxygen in large quantities. We have made in this way a large amount of gas, and have found it exceedingly pure. The proportions recommended are 3 parts salt to 4 of acid. We do not think, however, that this method will be much employed, as it is not so economical as that by means of chlorate of potash—a salt now sold in the market at threepence an ounce.

Another gas, which is of more importance in theory than in practice, is chlorous acid. When sulphuric acid and chlorate of potash made into a paste are distilled, a yellow gas comes over, the formula of which is $Cl{\cdot}O_4$. Its existence may be proved by a simple experiment. Place some chlorate of potash and phosphorus at the bottom of a test-glass filled with water, and then by means of a sucker add sulphuric acid. The gas is evolved and ignites the phosphorus.

Millon (L' Institut. 456.) forms this gas by introducing into a large glass flask 1 part tartaric acid, 4 chlorate of potash, 6 nitric acid, and 8 water; or, when it is desired to have it perfectly pure, the following mixture is to be used:—arsenious acid 15 parts, chlorate of potash 20, nitric acid 60, water 20. The arsenious acid and chlorate of potash are first pulverized, and formed into a paste with a little water. The mixture of nitric acid and water is then poured on them, and gentle heat applied. The materials should be quite pure.

The fact that calomel could be converted into corrosive sublimate, in the system, was known many years ago. But the exact circumstances of this transformation were not sufficiently understood. Mialhe, in an elaborate set of experiments on the subject, (Ann. de Chimie, v. 160.) says, the action occurs when calomel is brought in contact with a solution of an alkaline chloride, that the quantity of sublimate formed is in proportion to the amount of alkaline chloride present, and the action increases in proportion to the concentration of the alkaline chloride. His experiments were made with common salt and sal-ammoniac. The action is much increased by the presence of air and dextrine, but is retarded by fat and gum. By simply boiling calomel in distilled water, sublimate is formed. Mialhe extended his observations to all the compounds of mercury, and obtained similar results. He concludes that it is corrosive sublimate which is the active agent in medicine. If this idea should be confirmed, it should lead to the substitution of this form of mercury for all the others. The same chemist recommends the hydrous proto-sulphuret of iron as a complete antidote to corrosive sublimate. To prepare it, copperas is to be precipitated with hydrosulphuret of sodium, the precipitate washed and preserved in an air-tight bottle.

Fritsche of St. Petersburg has communicated to M. Chevreul (L'Institut. 460,) a method—an improvement upon that of Liebig—of separating indigotine, which he considers will serve for testing the value of commercial indigo. He takes 1 part of commercial indigo and 1 part of grape sugar, and places them in a flask capable of containing 40 parts of liquid. He fills half the flask with hot alcohol, and then adds 1½ parts of strong liquid caustic soda to another equal portion of alcohol, and fills up the flask with them. The flask thus filled is allowed to remain at rest till it becomes clear. The fluid is then withdrawn, by means of a syphon, into another flask. This liquid is first yellow, but, by exposure to the air, it changes to red, violet, and blue, depositing microscopical crystals, which are larger in proportion to the gradual admission of the oxygen of the air, and consist of pure indigo. They are then thrown on a filter, and washed rapidly with hot water, in order to remove a substance produced by the action of the soda on the sugar, which is insoluble in alcohol, but soluble in hot water. From 4 ounces of inferior indigo of commerce, he obtained, by the first infusion, 2 ounces of pure indigo blue: a second infusion of the residue gave only a drachm of indigo.

The subject of the digestion of food (Ann. de Chimie, v. 478,) is pregnant with much interest to man; and it may be affirmed, without hesitation, that the only light hitherto thrown on this function, has been through the medium of chemistry. Bouchardat and Sardras have lately confirmed the plausibility of the theory which views the process as the result of the action of dilute muriatic acid. This acid, they consider, dissolves the aliment to be assimilated, which is absorbed by the veins, and leaves the chyme, which may lose a small portion of its bulk in the small intestines, but is, in reality, a mass of undigested materials, ultimately constituting the excrementitious matter. The chyle they consider to be an alkaline fluid, secreted by the abdominal glands, destined to saturate in the blood the acid secreted by the stomach, because they found that the chyle always possessed the same composition, whether the aliment consisted of pure starch or fibrin. Fatty substances, they affirm, are not dissolved in the stomach, but pass into the intestines, where they are absorbed by the lacteals.

The observation by Liebig, that the fibrin of plants and animals is identical in its composition, led to the inevitable conclusion, that the animal organization merely modifies the state of the substances presented to it by the vegetable kingdom, and does not form any solids, as plants do, from their gaseous constituents; or, in other words, the fibrin or curd of milk exists ready formed in the vegetables which serve as the food of the cow, while the main constituents of the blood, in like manner, are derived directly from the vegetable matters which constitute the food primarily of all animals. No exception could be urged to this affirmation in reference to the formation of blood and muscle. The anomaly which presented itself was in the instance of fat, which, as far as experiment had carried us, did not appear to exist in sufficient abundance in vegetable food, to authorize us to ascribe its origin to such a source. Liebig quotes the instance of a lean goose, weighing 4 lbs., which, in 36 days, gains 5 lbs. weight by consuming 24 lbs. of maize, and yields 3½ lbs. of pure fat. The latter could not be derived from the maize, said Liebig, because maize, according to such experiments as had been made upon it before Liebig wrote, did not contain the thousandth part of its weight of fat. From whence came the fat? Liebig conceives it to be derived from the starch of the maize, by the simple abstraction of oxygen, and its evolution from the system by respiration, in the form of carbonic acid. The relation of the carbon to the oxygen in starch is 120 to 100; and in fat, 120 to 10. Liebig perceives, in this abstraction of oxygen, a fertile source of animal heat. This idea was strikingly supported by the fact, that bees, when fed upon honey alone, (a substance identical in its composition with starch,) form large quantities of wax. Now, wax approaches fat in composition, and both yield succinic acid when treated by nitric acid. These ingenious views of Liebig have led Dumas and Payen (L'Institut. 461,) to make a series of experiments, for the purpose of determining the quantity of fatty or oily matter in maize. They have found 9 per cent. of yellow oil to exist in this vegetable; hence they conclude, when a lean goose eats 24 lbs. of maize, it takes up 2½ lbs. of fatty matter, which, with the fat previously existing in the animal, is sufficient to account for the source of the 3½ lbs. of fat. Dumas adds the remarkable intelligence, that hay, such as it is met with in the trusses eaten by animals, contains 2 per cent. of fatty or oily matter. He considers that the pasture ox and milk cow furnish always less fat in proportion to its deficiency in the food; and that in the milk cow, the butter always represents nearly the fatty matter of the food. In the opinion of himself and Payen, the facts derived from farmers and from chemical analysis, agree in proving, that the milk cow constitutes the most exact and most economical method of extracting the azotized and fatty matter contained in pastures.

It is obvious that these facts, should they enable us to dispense with the explanation afforded by Liebig, of the production of fat from starch, go to substantiate the idea which he was the first to propagate, that the constituents of the blood and of the solid parts of animals generally, before they have undergone transformation, exist ready formed in plants.

Some years ago, Cap and Henry of Paris stated that *urea* exists in the urine, in union with lactic acid, under the form of lactate of urea without any water. As, however, Regnault had previously shown that all the salts of urea contained an atom of water, Pelouze was induced to ascertain if lactate of urea could be formed synthetically, by the addition of urea to lactic acid, and by double decomposition with lactate of lime and oxalate of urea. His attempts were unsuccessful, and his result in unison with the experiments of Liebig, who could never detect lactate of urea in urine. Pelouze could not succeed in combining urea with hippuric and uric acids. When nitrate of urea is heated to 302° F., carbonic acid and protoxide of azote are evolved, while free urea and nitrate of ammonia remain. During the decomposition of the nitrate of urea, a new acid is formed (L'Institut. 454) crystallizing in small whitish plates, which have not been accurately examined.

Chemistry has become of such essential importance to the agriculturist, that any experiments upon subjects connected with his art, must be viewed by him with gratification. In the choice of manures, chemistry has done much, and promises still more. Those who have examined the French journals, must be aware of the extensive experiments made on this subject by Boussingault. He has examined the question very extensively:—Is the proportion of azote present in a manure the test of its richness? He answers the query in the affirmative, although he does not deny the importance which other matters may possess. The following table is a selection from an extended series of experiments where the figures represent the equivalent numbers, farm manure being taken as unity. (Annales de Chim. iii. 65, N.S.)

Farm Manure, . . .	100	Flemish Manure, . .	210·5
Pease Straw, ...	22·3	Dry Muscle, ...	3·06
Wheat Straw, ...	166·6	Dry Blood, ...	3·69
Old Wheat Straw, . .	81·6	Animal Charcoal, . .	36·69
Lower part of W. Straw,	97·5	Dutch Manure, ...	29·4
Upper part of W. Straw,	30	Oak Leaves, in Autumn,	34
Oat Straw, ...	142·85	Poplar Leaves, in Autumn,	74·3
Barley Straw, ...	173·9	Guano, ...	80·4
Potato Tops, ...	72·72	Guano, ...	74·1
Carrot Tops, ...	47	Guano, ...	28·6
Pulp of Potatoes, . .	76	Urine, ...	2·4
Juice of Potatoes, . .	106·38	Urine, ...	55·9
Dung Water, ...	67·7	Refinery Charcoal, . . .	28
Cow Dung, ...	125·0	English Charcoal, . . .	5·75
Cow Urine, ...	90·9	Residue of Prussian Blue,	30·62
Horse Dung, ...	72·7	Sea Plants, ...	16·6
Pig Dung, ...	63·4	Sea Plants, ...	16·7
Sheep Dung, ...	36	Mould, ...	33·3

Great disparity exists between the different kinds of Guano according to the above table, which we have fully confirmed in our experience in Glasgow. We have met with Guano containing so small a per centage of ammonia as 4½ and as high as 15, facts which should induce purchasers to cause samples to be chemically tested before concluding their agreements. In the above table, the substances are supposed to be in the moist state and not dried. The table is read thus:—100 parts of farm manure are equivalent to 22·3 parts pease straw, or 36 sheep dung, &c.

M. Bizio of Venice has lately, in a communication to the French Academy, (L'Institut, 466,) given a description of the shells which supply the Tyrian purple, a dye of great celebrity among the ancients, and has sent specimens of these shells to the same society, along with a quantity of the fluid procured from the shells. The Tyrian purple is contained in the *Murex Brandaris;* the Amethyst purple in the *Murex Trunculus;* two shells which are very abundant on the shores of the Mediterranean. The liquid is contained in a large bag which is situated at the upper part of the animal, and may be extracted with great facility. All that is necessary is to break the shell with a hammer, and express the liquid from the bag by means of a spatula. The Roman dyers break the shells in their oil mills. The liquid, which is white and milky in the bag, oxidizes in contact with the air and light, and passes through all the shades of green to a more or less deep red. M. Bizio suggests that the dye should be tried at the Gobelin establishment in Paris. The same remark might be taken advantage of in Glasgow, where the communications with the Mediterranean are sufficiently frequent.

Lithofellic acid was obtained from a calculus by Göbel of Dorpat, and has since been examined by Will, Ettling, and Wohler. Heumann inferred that it was a constituent of bezoars or calculi obtained from animals probably of the deer tribe, although this fact has not been perfectly ascertained. Fourcroy and Vauquelin examined bezoars, and describe them as being soluble in alcohol, and separating in crystals as the solution cools. They concluded that the crystals consisted partly of bile, and partly of resin. These chemists may be said, therefore, to have first noticed this new acid, for Goebel did not any more than they analyse it. Ettling and Will first determined this essential point of distinction. While examining the calculi in the Hunterian museum of the University of Glasgow lately, four specimens of lithofellic calculi were detected. Half of one of these containing a date stone as a nucleus, is about $1\frac{1}{2}$ inch long, $\frac{7}{10}$ inch broad, and weighs 71 grains. Half of another measures $1\frac{9}{10}$ inch long, $1\frac{1}{10}$ inch broad, weighs 169 grains, and contains a nucleus of hair and vegetable fibres. They are formed of alternate brown and yellow layers; they dissolve in alcohol and pyroxylic spirit, leaving a yellow flocky matter. From a fragment of one of them we extracted lithofellic acid by the following process, in the University laboratory: the fragment was boiled with spirits, the solution evaporated, and digested with caustic soda, which dissolved the whole of it. The alkaline solution was precipitated by muriatic acid, when a white resinous precipitate fell possessing great ductility and adhesiveness. The precipitate was well washed and dissolved in alcohol. By repeated solution in alcohol and slow crystallization, the acid was obtained in tolerable large crystals with a shade of green, but the crystalline form was not sufficiently regular to admit of definition. Some portion was obtained in small crystals of such purity, it was thought, as to admit of analysis, but it was not perfectly pure, as it only gave 69 per cent. of carbon and 10·63 water. We formed also the nitro-lithofellic acid, by the action of nitric acid on lithofellic acid, but not in sufficient quantity for analysis.

The chemists of the Continent who have hitherto adopted the atomic weights determined in Sweden, without calling their accuracy in question, have lately had their attention drawn to this important subject by Dumas, since his visit to this country, who, followed by others, has established the accuracy of the following atomic weights, determined more than twenty years ago in the Glasgow University laboratory:—

Chlorine,	4·5	Potassium,	5·
Hydrogen,	·125	Calcium,	2·5
Azote,	1·75	Silver,	13·75
Carbon,	·75	Lead,	13·

It may not be an uninteresting fact in the history of atomic weights, to state, that in 1813, or twenty-nine years ago, (Annals of Phil., iv. 42,) Dr. Thomson deduced ·751 as the atomic weight of carbon, from the specific gravity of carbonic acid, confirmed by his analysis of olefiant gas. The atomic weight of azote, in the same year, he also deduced from nitrous gas as ·878, almost the half of the present number, for $\cdot 878 \times 2 = 1\cdot 756$. It was from these numbers as a starting point, that Dr. Prout was first led to infer the theory of multiple atoms.

R. D. T.

Since the preceding report was read, a communication has been made by Fremy to the academy of Paris, in which he shows, that besides iron and tin, many other metallic oxides act the part of acids, and, what is curious, that their capacity of saturation increases with the quantity of water united to them; their electro-negative properties are lost when they are anhydrous, (L'Institut. 468.) He has obtained a crystallized aluminate of potash, consisting of an atom of each and two of water. *Bizincate* of potash is obtained in long needles by treating oxide of zinc with potash, and a little alcohol. *Bismuthate* of soda is obtained by heating oxide of bismuth with soda. *Plumbites* are the result of the action of protoxide of lead on alkalies, and *plumbates* of the brown oxide. Minium Fremy considers a *plumbate* of *protoxide* of *lead*, analogous, therefore, to the chromate of chromium described by Dr. Thomson in 1824.

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PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTY-FIRST SESSION, 1842-43.

CONTENTS.

14*th December*, 1842,—*The* President *in the Chair.*

Messrs. Andrew Stein and William Graham were admitted Members of the Society. Mr. Liddell suggested that, to avoid the Christmas week, the next meeting of the Society should be postponed till the 4th January. The Vice-President having taken the Chair, the following papers were read:—

XXII.—*On the Melting Points of Alloys of Lead, Tin, Bismuth, and Zinc.* By Thomas Thomson, M.D., F.R.S., *Regius Professor of Chemistry.*

As the first three of these metals melt at temperatures below the boiling point of mercury, the determination of the melting points of their alloys is attended with little difficulty. Zinc, according to the experiments of Daniel, melts at 773°, which is above the range of a mercurial thermometer; but when tin is alloyed with it the melting point is considerably under 662°, which is the degree of Fahrenheit's thermometer at which mercury boils.

Though these experiments are of easy execution, I am not aware of any person having tried them, except Kupfer in 1829, and Rudberg in 1831. Rudberg made a careful examination of the melting point of alloys of tin and lead, tin and bismuth, zinc and tin. But he informs us that his thermometer was inaccurate, while he forgets to state the amount of the inaccuracy. So that we cannot consider the points which he has stated in his tables as the true melting points of these alloys. The object which he had in view was to determine the latent heat of melted lead and tin; and he accomplished this by measuring the length of time that the melted metal took to cool a certain number of degrees. Hence the inaccuracy of his thermometer did not affect the result of his experiments. I shall notice Kupfer's experiments at the end of this paper.

I may here notice a curious mistake into which Rudberg has fallen. He says that Dr. Black reckoned the latent heat of tin 500°, and that of wax 175°. These latent heats were determined, not by Dr. Black, but by Dr. Irvine, while professor of chemistry in the College of Glasgow. Rudberg has mistaken the meaning of Irvine's conclusion. When he says that the latent heat of tin is 500°, he does not mean the number of degrees that the same weight of water would be raised; but the increase of temperature which the latent heat of tin would produce in the tin if it were to be thrown into the solid metal without melting it. The heat which would raise tin 500° would only raise water 33°. Hence the latent heat of tin, as referred to water, according to Dr. Irvine's experiments, is 33°, while by Rudberg it is 25°. The difference is not nearly so great as Rudberg supposed. It is probable, from the care taken by Rudberg in his experiments, that his determination is nearest the truth.

I find that, when lead and tin are alloyed together, in all the proportions tried, the alloy expands, or is more bulky than the two metals when separate. Hence the specific gravity of the alloys is less than the mean. The specific gravities and atomic weights of the metals I used were—

	Specific Gravity.	Atomic Weight.	Kupfer.
Lead, . .	11·357	13·	11·3303
Tin . .	7·285	7·25	7·2926
Bismuth, .	9·833	13·5	
Antimony, .	6·436	8·	
Zinc, . .	7·000	4·125	

I first melted together lead and tin in the proportions of

1.	2.	3.	4.
1 atom lead.	1 atom lead.	1 atom lead.	1 atom lead.
1 atom tin.	2 atoms tin.	3 atoms tin.	4 atoms tin.

All of these alloys are malleable, and they all have a specific gravity below the mean. Hence tin and lead expand in the act of uniting, and occupy a greater volume than when separate. The following table shows the specific gravity of these four alloys:—

	Sp. Gr.	Mean Sp. Gr.	1000 become	Melting Points.
1, . .	9·2879	9·899	1066	360°
2, . .	8·688	9·209	1060	361°
3, . .	8·549	9·002	1048	361°
4, . .	7·850	8·545	1088	374°

I was surprised to find the melting points of all these alloys so near each other. Rudberg had observed the same thing, though from the error in his thermometer we cannot deduce from his tables the true melting point.

The melting point of lead, determined from the mean of a great number of trials, is 607°, and that of tin 442°. The mean of these two points is 524½°, which is 163½° above the actual melting point. We may conclude from this that tin possesses the important property of lowering the melting point of other metals—a property which the facts about to be stated fully confirm.

Lead and bismuth were now melted in the following proportions:—

1 atom lead. 1 atom bismuth.	1 atom lead. 2 atoms bismuth.

The melting points of these alloys were—

1, ... 274°	2, ... 263°

In this case the two alloys have each a melting point peculiar to itself. The melting point of bismuth is 497°, and that of lead 607°. The mean is 552°. So that the melting points of alloys of lead and bismuth are respectively 278° and 289° below that mean. Bismuth has a still greater power to diminish the melting point of other metals, or at least of lead. The alloy is white and rather beautiful; but quite brittle. This is the case with all the alloys of bismuth, at least so far as I have tried.

When bismuth and lead unite, the bulk of the alloy diminishes, and consequently the specific gravity is above the mean. The following table shows the specific gravity, and the diminution of bulk in these alloys—

	Sp. Gr.	Mean Sp. Gr.	1000 become
1, . . .	10·831	10·580	977
2, . . .	10·509	10·328	983

Seeing that both tin and bismuth sink the melting point of alloys, it became an object to observe what the melting point of alloys of these two metals would be. The two following were made:—

1.	2.
1 atom tin. 1 atom bismuth.	2 atoms tin. 1 atom bismuth.

The melting points of these two alloys were—

1, ... 280°	2, ... 274°

These points are not lower than those of the corresponding alloys of lead and bismuth.

The alloy of tin and bismuth is white, and more pleasing to the eye than pewter; but, like all the alloys into which bismuth enters, it is brittle.

I may mention here that *pewter* consists chiefly of an alloy of zinc and tin, with the addition of some bismuth and copper. Common pewter is an alloy of 1 part by weight of zinc and 17 of tin; while plate pewter is said to be

100 zinc, 8 tin, 2 bismuth, and 2 copper:

while another kind of pewter is mentioned composed of 4 zinc, and 1 lead, called ley pewter.

When tin and bismuth are melted together they expand; for the specific gravity is less than the mean. The amount of expansion will appear from the following table:—

	Sp. gr.	Mean sp. gr.	1000 become
1, . . .	8·709	8·942	1027
2, . . .	8·418	8·5135	1011

Tin and zinc constituting common pewter, I thought it worth while to determine the melting point of these two metals. The melting point of zinc is above the range of a common theremometer, being, according to Daniell, 773°. But I thought it probable, as tin lowers the melting point of lead, that it might have the same effect on zinc. And I found it so. I made two alloys, the first composed of 1 atom tin, and 1 atom zinc; and the second of two atoms tin, and 1 atom zinc. The melting points—

1, ... 384° | 2, ... 386°

obviously approaching very near each other, and probably identical. The mean melting point of an alloy of tin and zinc is 607½°, which is 212° higher than that at which the alloy really melts.

The alloy of tin and zinc is malleable. It is much more beautiful than zinc, and in fact, has a close resemblance to pewter. When tin and zinc are melted together they expand, and the expansion for 1 atom tin, and 1 zinc, is greater than in the case of lead and tin. This will appear by the following table:—

	Sp. gr.	Mean sp. gr.	1000 become
1 atom tin, 1 atom zinc, . . .	6·426	7·1815	1117
2 atoms tin, 1 atom zinc, . . .	7·231	7·222	1001

There was some difficulty in uniting these two metals. The zinc does not melt till it becomes nearly red hot. The consequence was, that the tallow which I threw into the crucible to prevent oxydizement, caught fire. There was always a little dross floating on the top, which was probably zinc. This might occasion some error, and might be the cause why the melting points of the two alloys did not agree exactly.

To try whether antimony would have any effect in lowering the melting point of lead, I made an alloy of 1 atom lead, and 1 atom antimony. But the melting point being above 650°, I could not determine it by a common thermometer. According to Guyton de Morveau, the melting point of antimony is 953°; but his points are all a great deal too high. Dr. Cromwell Mortimer had long ago determined it to be 810°, which I believe to be near the truth. Now, the mean melting point of an alloy of 1 atom lead, and 1 antimony, is 708°, and I believe that the true melting point is very little inferior; it is above 650°. This alloy is a fine white; it is brittle, and expands when the two metals unite.

	Sp. gr.	Mean sp. gr.	1000 become
1 atom lead, 1 atom antimony, . . .	9·222	9·482	1028

As tin has the property of lowering the melting points of lead and zinc, I thought it worth while to try whether it had the same effect on antimony. Accordingly, 800 parts of antimony were melted with 725 parts of tin, constituting the equivalent of an atom of each. The alloy was very brittle; its fusing point was considerably above 600°, so that I was unable to determine it by a thermometer; but I consider it as nearly the mean between that of antimony and tin. Its specific gravity was 6·927; it ought to be 6·839. It is therefore heavier than the mean; 1000 parts when alloyed become 989, or diminish in bulk $\frac{11}{1000}$ parts.

I shall terminate this paper with a remark, which I consider as of some interest.

If you plunge a thermometer into melted lead, and observe it with attention, you will find that it will sink constantly till it reaches 607°, but here it will remain stationary for at least two minutes; (provided the quantity of lead be considerable, half a pound for example;) and when it begins to fall again, it will be found that the lead has become solid. Hence, the stationary temperature marks the melting point of the metal.

If we try the same process with tin, the thermometer will sink to 438°, and, after remaining for a little while there, it will start suddenly to 442°, at which point it remains stationary much longer than in the lead; and when it begins to fall again, the tin will be found solid. Hence, 442° is the melting point of tin.

When we dip a thermometer into a melted alloy of lead and tin, and observe the rate at which it sinks, we shall find that it will show two stationary points,—the first a good deal shorter than the second. I call these, by way of distinction, the *short* and the *long* stationary points. The first stationary point continues for about a minute: the second is seldom shorter than three minutes, and sometimes much longer. The greater the proportion of lead, the higher is the first, or short stationary point, and the more tin the lower it is; so that, in an alloy of 1 atom lead and 4 atoms tin, the two stationary points nearly coincide.

The following table shows the degree that coincides with the short stationary point in various alloys of lead and tin:—

Lead.		Tin.		Short.	Long.
1 atom	+	$\frac{1}{3}$ atom	. . . .	536°	
1 —	+	$\frac{1}{2}$ —	. . . .	518	
1 —	+	1 —	. . . .	464	360°
1 —	+	2 —	. . . .	392	361
1 —	+	3 —	. . . .	361	361
1 —	+	4 —	. . . .	374	374

Now Kupfer gives the melting point of different alloys of lead and tin as follows:—

1 atom lead + 1 tin, . .	460°	1 atom lead + 3 tin, . .	367°
1 — + 2 . .	385	4 — + 1 . .	272

It is obvious that he has taken it for granted, that the short stationary point indicates the melting point of these alloys, while in reality it is the long stationary point which indicates the temperature at which they change their state from liquidity to solidity.

XXIII.—*Notices of some Recent Botanical Facts.*

Much has of late been written on the subject of the devlopement of parasitic plants upon man and animals in certain states of disease. Attention was early directed to the subject by Audouin and Bassi, who examined the disease in the silk-worm, call *Muscardine,* which they showed to be accompanied with the growth of a cryptogamic plant, afterwards designated *Botrytis Bassiana.* Since their observations were made known, plants of a similar nature have been detected on various larvæ and insects. Deslongschamps found a parasitic fungus or entophyte in the air cells of an eider duck, which died after suffering from dyspnoea for nearly a month. Vegetations have likewise been noticed in pigeons, domestic fowls, flamingoes, paroquets, and owls, as well as on gold fishes. In most of these cases the fungi appeared in the form of transparent articulated filaments, some of which presented bodies analogous to sporules.

Schoenlein and Langenbeck observed similar cryptogamic vegetations in the disease called *porrigo favosa,* as it occurs in the human subject; and of late years Gruby, of Vienna, has taken up the investigation, and has given a full detail of the *mycodermata* which are met with in that disease. These mycodermatous plants, or *porrigophytes,* have their seat in the cells of the epidermis, and consist of articulated filaments, of a diameter varying from the $\frac{1}{1000}$ to the $\frac{1}{250}$ of a millimetre. Dr. Bennet has confirmed Gruby's researches.

In the *aphthæ,* or *thrush* affecting the mucous membrane of the mouth in children, as well as in the disease called *mentagra,* which has its seat in the hairs of the face and chin, vegetable productions have likewise been discovered. They differ slightly from *porrigophytes*, and have been called by Gruby, *aphthaphytes*, or *mentagraphytes*.

Dr. Bennett remarked cellular plants of the same kind in the mucous membrane of the lungs, and in the sputa of a patient labouring under pneumo-thorax with tubercles. They resembled in many respects the *Penicillium glaucum* of Link.

All the cryptogamic vegetations to which we have referred, are considered by most authors as the result, and not the cause of disease. They seem to make their appearance in cases where the constitution has been enfeebled.

More recently Mr. John Goodsir observed in the fluid ejected from the stomach of a patient labouring under a particular form of dyspepsia, accompanied with water-brash, a vegetable formation, allied to the *Diatomaceæ*, (a division of sea-weeds.) From its peculiar form and locality, he has given it the name of *Sarcina ventriculi*. It is microscopic, of a square form, its parts being arranged in a beautifully symmetrical manner. The number of cells of which the perfect plant consists, is 64. It propagates by the division of these 64 cells into four new ones, so as to consist of 256 cells,—and simultaneously with this increase in the number of parts, divides into four young plants. In the fluid ejected from the stomach, a large quantity of free acetic acid was found.

Similar bodies have been met with by other observers; more especially by Mr. Busk, who considers them, however, as not of vegetable origin, but as ferments, and probably modified epithelial cells of the stomach.

Mr. Hassall attributes the rapid decay of many fruits, especially apples and pears, to the formation of fungi in their interior. They are of the mucedinous group, and occur in the form of ramified filaments, which disturb the relation of the cells of the fruit, and stop the process of endosmose. The disease commences on the outside of the fruit and quickly spreads. The fungi produce sporules which communicate the disease rapidly. Hence, the importance of removing decayed fruit, and of keeping a fruit-room dry and airy.

Another subject taken up by Mr. Hassall, is the different forms assumed by the pollen of plants. The grains of pollen are found to vary much in shape and in external aspect, as well as in the number of tubes protruded from them. Characters derived from the pollen may thus be employed in classification. In endogenous plants the granule of pollen is spherical, oval or elliptical, and generally composed of two membranes, rarely possessing more than one pollen-tube. In exogenous plants the granule is more complicated, has two, three, or four enveloping membranes, assumes various forms, such as three-lobed, spherical, or triangular, and emits pollen-tubes varying from three to upwards of fifty. Natural orders are characterised by having a pollen granule of one type, and the more natural an order the more frequently will this be the case.

J. H. B.

4th January, 1843,—*The* PRESIDENT *in the Chair.*

Messrs. Peter M'Intosh, George Sutherland, and Thomas Hill, were admitted as Members of the Society. The following communication was read:—

XXIV.—*Practical Remarks on Blast Furnaces.* By GEORGE THOMSON, ESQ., *Mining Engineer.*

THERE is a manifest absence of any thing like correct principle in iron smelting; and although the reduction of ore by cementation may be an easily explained operation, yet, the peculiar combinations brought to bear in the blast furnace, seem to present a problem which chemical science is as yet unable to explain.

In the attempted solutions of the problem, a too limited number of facts have been generally considered, and generalizations attempted, from facts bearing partially on unvaried conditions. Following the system of induction, if a true principle is only to be attained through the medium of facts in every variety and under every possible condition, the object may be assisted, in some measure, by my laying before the Society a few facts which have come under my own observation, and may be peculiar. The results given are divided into three principal conditions, viz: 1st, as respects the direct influence, *cæteris paribus,* of different material. 2d, Influence of shape and size. 3d, Influence of blast, as to diffusion, pressure, or quantity.

1st, *Influence of material.*—Although *all* the materials used in smelting have a certain influence; it is the coal which gives the most extraordinary results as respects "yield." A few results of various coals are therefore collected into the following table from my own immediate observation. The word "yield" is used to denote the comparative quantity of coals used in the furnace, to produce, or to smelt a ton of iron. In the table, the weekly quantity of iron given, as produced by hot blast, is small in comparison with what is now made at most furnaces; yet these are the more correct *comparative* results, having been attained with like conditions of size, shape, number of tweres, &c. Since that time, the shape and size of furnaces have been materially altered, as well as other conditions, and the make greatly increased.

TABLE No. I.

PLACES.	COALS.			RESULTS.				
				COLD BLAST.		HOT BLAST.		
	No.	Local Name.	Loss in Coking.	Coal to a Ton of Iron in Furnace.	Weekly Produce from One Furnace.	"Raw," or Coked.	Coal to a Ton of Iron in Furnace.	Weekly Produce from One Furnace.
SHROPSHIRE, (Lightmoor Works,)	1	Clod Coal, ...	45 per Cent.	3 Tons.	70 Tons.	Coked.	2½ Tons.	80 Tons.
	2	Yard Coal, ...	50 —	5 to 5½	40	Coked.	2½ to 3	80 —
	3	Little Flint Coal,	50 —	4	50 to 60	Coked.	2⅓ to 3	80 —
		Do.	Uncoked.	2½ to 3	50 to 60			
SOUTH STAFFORDSHIRE, (Wedensbury Works,)	4	Thick Coal, ...	45 per Cent.	3	60	Raw.	2¼	80 —
	5	Tipton Coal, ...	45 —	5½	35	Raw.	2½	60 —
NORTH STAFFORDSHIRE, (Fenton Park,)	6	Ash Coal, ...	50 —	5½	35	½ Coke, ½ Raw.	3½	45 —
	7	Rider Coal, ...	55 —	7½	25	Coked.	4¼	40 —

DESCRIPTION OF COALS.

No. 1 is soft, stratified, and dull; horizontal sections filled with carbonaceous matter; burns with a white ash; produces a soft coke, which retains carbonaceous matter in divisions.

No. 2.—Rather hard, cubical and bright; calcareous matter in transverse divisions; burns to a brown ash; produces a hard coke, and is considered very sulphury.

No. 3.—Hard, cubical, shining; burns to a white ash; produces a very hard coke.

No. 4 is of various stratifications, differing in character; is generally known.

No. 5.—Schistous, very friable, with carbonaceous matter between horizontal layers.

No. 6.—Bright, conchoidal, free burning, and renders a white ash; is preferred for burning the china and "pottery ware" of the district.

No. 7.—Bright, conchoidal, burns very hot, leaves a brown ash. A stratum of pyrites lies directly below it in the coal field of about 6 inches thick.

Referring to the Table, the three first coals are found in the same coal-field, and at no very great depth from each other. The cold blast results of these came directly under my own observation, and are taken from several years work; the hot blast results are from a neighbouring work, and subject to similar conditions in almost every respect. Here, then, in the same coal-field are three different coals, which, when under similar conditions with cold blast give very different results, so much so, as to have taken nearly twice as much of one kind of coal to make a ton of iron as of another, (yard coal $5\frac{1}{2}$ tons, clod coal 3 tons); but when the hot blast is applied, we find they are very nearly assimilated, so that, upon the coal which works *best* with cold blast, that application has scarcely any effect, while on the inferior coal it has a most surprising one.

The two next coals in the table from the Wolverhampton coal-field show a similar result. The sixth and seventh, or the two last coals of table No 1, belong to North Staffordshire—the district of the "Potteries." There my results are also given from a direct personal observation of several years; and I do not think I err in saying, that the materials of this district, taking coal and ironstone together, are the worst in the kingdom for iron smelting. The coals given are compared under precisely similar conditions both with cold and hot blast, and although obtained from the working of a very small furnace, (only 32 feet high,) the *comparative* results will not be affected thereby. They lie very close to each other, being merely separated by a stratum of shale a few feet in thickness, often less, and, consequently, show how great a difference occurs, not only in different districts, but within a few yards, vertically, of the same field.

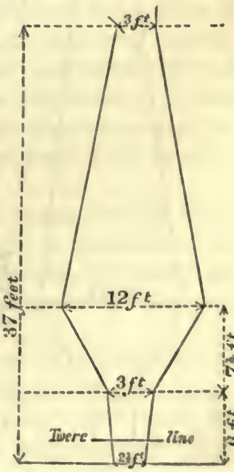
With modifications of shape and increase of size, (to which we shall attend more particularly under that head,) we were ultimately able to work No. 6, (ash coal,) in the furnace, without coking, and at a consumption of only $2\frac{1}{4}$ tons to the ton of iron, with a make of upwards of 70 tons a week; but No. 7, (rider coal,) although these conditions altered the make considerably and the yield slightly, we were never able to work *without* coking; again and again we tried to do so by commencing with a small quantity and gradually increasing it, but in vain; every increase of this coal to the burden, without coking, was followed by a decrease of yield, make, and quality.

As regards ironstone, the effects of different qualities are not so striking as those of coal, with respect to *yield*, but they have a great influence on the *quality* of the iron produced. For instance, that which is known as the Shropshire pennystone—a peculiar kind of argillaceous ironstone found in small nodules imbedded in a stratum of indurated clay—and containing about 30 to 35 per cent of iron, is supposed to give the peculiar strength and toughness to the Shropshire pig iron. When another ironstone, (siliceous,) locally termed "crawstone," which is found partially stratified in a bed of sandstone rock, is mixed with the pennystone, even in proportion of 1 to 10, the effect is very observable in making the iron much more fluid, although it retains its stoutness. Again: the effect of the "red ore" of Cumberland, or peroxide of iron, mixed with argillaceous, or other ironstone, is well known; it adds in every case very materially to the strength of the iron, and the effect is especially so with the hot blast. Forge cinder, which is a protoxide of iron, mixed with siliceous or other foreign matter, has a directly contrary effect both with cold and hot blast. So much so, indeed, that I have seen hot blast iron which had been made with a large proportion of "cinder" so weak as to break into several pieces when dropped on the ground from the height of a couple of feet. I may here remark, that it is not surprising that we should hear so many conflicting opinions on the *strength* of hot blast pigs, by those who only quote results without considering the conditions which affect them.

These results on the quality of iron by the use of different kinds of ironstone, are very general, but such effects are well known and are constant; and when we consider that there is only one kind of iron, in fact, surely it is worthy the attention of the scientific to inquire whence arise such differences, and how they should be produced by a simple mixture of "red ore," or of "forge cinder."

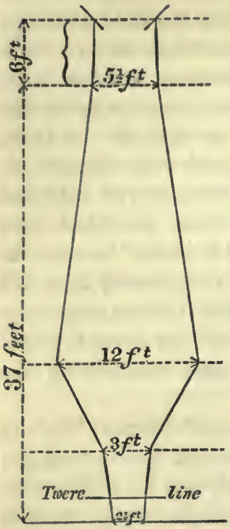
2d, Influence of shape and size.—We now come to a few results connected with the shape of furnaces; and on this point there seems to be at different times a ruling fashion. At the time of making the experiment to which I shall first refer, which was before the hot blast had been brought into notice, the prevailing fashion in England was to make the furnaces as narrow as possible, both at the "neck," (or filling place,) and at the "hearth." The furnace on which the experiment was made was at Lightmoor, in Shropshire, the shape and size of which is represented fig. No. 1. It worked worse than any of the others with the same coal, which was a mixture of those already referred to in Table I; and the only difference of its shape, compared with the others, was in being about 6 to 9 inches wider at the boshes, and 3 feet less in height.

FIG. 1.



This furnace consumed about 5 tons of coals in producing a ton of iron, and made only about 40 tons per week. The alteration made upon it was very simple to appearance, consisting only of widening the top from 3 *feet*, to 5½ *feet diameter*, and carrying that width perpendicularly up 6 feet higher; also placing two filling holes, one on each side, over tweres, instead of one in the middle, merely, as it were, placing a cylinder of 5½ feet diameter

FIG. 2.

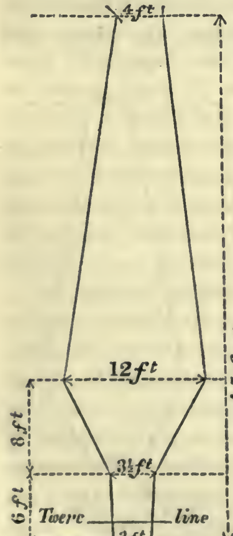


and 6 feet high upon the top, as represented in fig. 2.

Simple as the alteration appears, however, it was followed by very extraordinary results; the moment the charge arrived at the bottom, the iron, from hard forge, became fine No. 1. The burden was accordingly increased from time to time, until this furnace, with the same material and same blast, made 60 *tons* per week of good forge pigs, with a consumption of only 3½ *tons* of coal to a ton of iron. The result is not attributable to the widening and double-filling holes *alone;* for the effect was repeatedly tried by filling-holes at the *original height directly under* the upper ones, and in every case we had to take burden off to make an equal quality, thereby reducing both the quantity and the yield.

Mr. Gibbons, of Corbyns Hall furnaces, near Dudley, has arrived at very striking results with cold blast, by alteration of shape and increase of size. He states in his publication on the subject, that he was led to the idea by observing the well-known fact, that furnaces, especially cold blast ones, scarcely ever come into full work until six months after they have been blown in; and also, that every year, so long as the "boshing" of the furnace is not wholly gone, they improve their work both in yield and in quantity; further, in observing that furnaces, when blown out, although they had not been working for more than six or eight months, were materially altered from their original shape. By studying the natural shape, as it might be termed, he has arrived at an improved form, as at fig. 4.

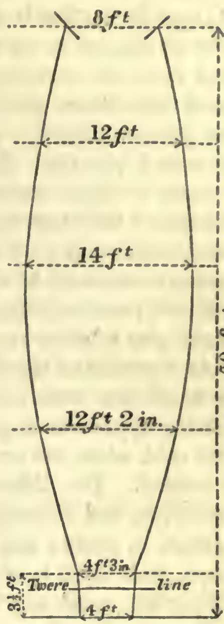
FIG. 3.



This improved furnace (fig. 4,) has more than double the capacity of his original one, (fig. 3,) and the larger content is in the *upper half*—the top is 8 feet diameter, and there are four filling-holes. The greatest produce of his original furnace he states to have been 74 tons per week, while that of the improved one has reached 115 tons in one week. This is by *cold blast,* with a density of only 1 lb. 13 oz. per inch at the twere.

Mr. Gibbons' opinion, like that of many others, is, that with the hot blast, the shape or the size has very little effect; but that this is not the case is now well known.

Fig. 4.



3*d, Influence of Blast.*—In cold blast working, some practical men hold that the density of the blast should not exceed 2 lbs. to the inch, while others work it as high as 3 lbs. to the inch, or even more. In re-smelting also in the cupola, many prefer the fanners, which give a much *softer* blast than the old method of the cylinder; while others, after having tried the fanners, have returned to the original and *stronger* blast of the cylinder. We cannot suppose that this is altogether fancy or prejudice; I have no doubt that the differences of the material subjected to the blast, is the cause, in a great measure, of such opposite results.

At Lightmoor, the various requirements of blast to make the best yield, with the different coals, were striking; coal No. 1, (of Table I,) which is the best, required a considerably less dense blast than the inferior, No. 2, (yard coal.) Indeed, blast, either in volume or pressure, seemed to be of little consequence to the working of the clod coal—from 1¾ lbs. to 2¾ lbs. to the inch, the yield was not affected, the only difference being a slight increase of quantity. Nor did diffusing the blast by a number of tweres seem to make a material difference. It is a fact that, with this coal, and a furnace of ordinary dimensions, 60 tons of iron have been made in a week by *one blast pipe only,* the muzzle only 3 inches diameter, or 9 circular inches of blast.

On the other hand, the inferior, or as they are called there, the "sulphury" coals, required a highly compressed blast to bring them to their best yield—one under 2½ lbs. to the inch gave very inferior results; compare this with Mr. Gibbons' result—his materials seem well adapted for cold blast working—and we find density of blast not a great object to them. 1 lb. 13 oz. only was his density at tweres, and this continued the same although he doubled the capacity of his furnace.

These general facts seem to contradict the opinion, that the whole *rationale* of the effect of the hot blast is merely a decrease in the density of the blast, because, with the inferior material, which requires with *cold* blast the *greatest* density, the *hot* blast has the greatest and *best effect.*

Those who are acquainted with cold blast working, know that most materials work best with what is technically called a "snuff" at the tweres; and to form this it is usual to blow a few inches below the surface of the scoria, which floats on the iron in the hearth. The "snuff" is a kind of arched tube formed by the cinder at the end of twere in the inside of furnace, and through which the blast passes. Now it appears to me that this natural muzzle of cinder has a great deal to do in diffusing the blast in contact with the material; and, mark that those materials which, from inferiority, required blast of the greatest density, gave the greatest trouble at the tweres, and presented practical difficulties in the "snuffing," which required a great pressure mechanically to overcome, and clear away for the passage of the blast upwards; for *such* materials (from what cause I know not) always work with great uncertainty at the tweres—sometimes having a tendency to stop up entirely, at others not snuffing at all.

If this practical difficulty could be avoided, perhaps the bad material might give a better result with a soft blast than we found it to do.

As regards the blast's density, when used hot, it must of necessity be much less than cold; for the quantity of air injected from the blowing apparatus is, generally speaking, no more with hot blast than with cold, while the area of the nose-pipes, taken together, is doubled or trebled. The diffusion of the blast by increasing the number of nose-pipes, and disposing them around the hearth, has produced great increase in make; and in some cases by this, together with increased shape, coals have been brought to work raw, which, with the first hot blast trials, could only be used when coked.

It seems agreed on all hands, the greater the number of the tweres around the hearth the better: and as I am aware that practical difficulties occur in doing so by the furnace "blowing forward," I will state a simple plan by which we overcame the difficulty. In building our furnace we had a round base, as is now common, but instead of the usual four openings, we made five—one for the opening of the hearth, and *four for tweres.* By this method the blast from one twere does not blow against the other, and neither of them blow directly to the fore part; thus *eight tweres* may be used—two at each twere side.

More pressure is required even with hot blast to work some materials than others. For instance, we required but 2½ lbs. per inch in North Staffordshire when working coke, but with coal, 3 lbs. per inch, with much greater heating surface, was required. The quantity of blast required here was very great. Blowing at four sides, we injected into a furnace fully 3000 cubic feet of air per minute, and heated to a high temperature. If this pressure happened at any time to be reduced, the effect was immediately perceptible, or if one of the tweres was taken off, a falling off in quantity and yield was the immediate consequence. The materials were, as I have before noticed, the worst I ever saw; both coals and ironstone being sulphury.

I will give only one other fact, a very extraordinary one, showing a most peculiar effect produced by a *simple increase of temperature,* at a work near Tipton, where the materials are of fair quality. The furnace upon which the experiment was made is only 11½ feet at "bosh," and

45 feet high, worked with raw coal and hot blast; it produced 100 tons a week, being blown with five tweres, of 3 inches diameter each.

The cross pipes of the heating apparatus were four inches diameter, and one apparatus supplied all the tweres.

The alteration was this—the number of heating pipes were increased, the cross pipes increased in size from 4 inches diameter to 7 inches diameter, and the main pipes also enlarged; the top of the furnace widened from 4 feet diameter to 7 feet diameter; the number of tweres increased from five to six, (two on each side and two at back,) each of 3½ inches diameter; a new steam cylinder of greater power was put to the blast engine, but the blast one was kept at same size.

The consequence is, that more than 150 tons of iron have been produced at this furnace in one week, with an improvement of yield, and the *engine goes no more strokes*, showing that actually no more *air* is forced into the furnace than when making only 100 tons a week, (two-thirds of present quantity,) although with a much greater area of nozles.

TABLE No. II.

COLD BLAST.				
	Pressure in lbs.	Total area of Nose pipes in Circular Inches.	Capacity of Furnace, Cubic Feet.	Weekly make of Iron.
Works near Glasgow,........	3	12·5	2500	45 Tons.
Lightmoor Works, with *bad* material,............	3	15	2000	45 —
Same, with *good* material,	2½	12·5		65 —
Fenton Park, with *bad* material,..................	2½	12·5	1000	25 —
Corbyns Hall, Mr. Gibbons, *good* material,....	2	18·2	4000	115 —
HOT BLAST.				
	Pressure in lbs.	Total area of Nose pipes in Circular Inches.	Capacity of Furnace, Cubic Feet.	Weekly make of Iron.
Works near Glasgow,........	2¼	18	2500	60 Tons.
Fenton Park Works,.........	2½	27	1000	40 —
The same, with different shape of furnace,.......	3	36	2500	70 —
Tipton, (a Work at).........	2¼	45	2200	100 —
The same, with increased heating surface, but no greater *quantity* of blast,	2¼	72	2600	150 —

I give a short table of the pressure of blast, which shows that the quantity of blast bears no constant proportion to the capacity of furnace nor to the make. The results given from the Glasgow furnaces are taken from data by M. Dufrenoy in 1833,—but since that period, the areas of nose pipes, and the number, and consequently make, have been increased as at other places.

This table shows that the quantity of blast varies with different material to produce the same quantity of iron, especially with cold blast,—with hot blast the *areas* bear little relation to the actual quantity of air injected, which cannot be arrived at without the capacity of the blowing cylinder and speed of engines.

The tables and statements are much more general than I could have wished; at the same time I think they sufficiently show that, 1st, there is a remarkable difference in the material of different strata in the same coal fields; 2d, that modification of shape and alteration of capacity have a very considerable effect; and 3d, that the effect of blast is very various with different materials; that an alteration of its temperature, with certain coals, produces a saving of in some cases one-half, in others two-thirds of the quantity, while with other coals the difference is scarcely perceptible, and the quantity of blast has little relation to the quantity or bulk of material acted upon.

The improvements in iron smelting have been effected simply by the observation and consequent successive trials of practical men; they have been the result of no principle previously established,—no theory obtained from the laboratory of the chemist:—and further, I think it cannot be denied that the anomalies apparent under each condition into which I have divided my results, present a problem which, as far as chemical analysis has yet gone, it is difficult to solve. And it must surely be admitted that, had these conditions been previously laid down to any one well acquainted, theoretically or practically, or both, with the manufacture of iron, together with a careful analysis of the material here referred to, he would never have predicated such results as have in reality accrued.

That the want of a guiding principle is greatly felt, and its attainment greatly to be desired, needs not to be set forth; and as there is no effect without a cause, I do not see that the number of apparent contradictions in these ought to make us in the least despair of ultimately attaining, by the powerful aid of science, a satisfactory rationale of the whole case. This, however, will never be done by avoiding the question—by taking a partial view of facts.

Mr. John Alston described Williams' apparatus for consuming smoke, and exhibited a model.

BELL AND BAIN, PRINTERS, GLASGOW.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTY-FIRST SESSION, 1842-43.

CONTENTS.

18*th January*, 1843,—*The* PRESIDENT *in the Chair.*

Drs. M'Neil, Quinlin, and Messrs. Thomas Johnston, Thos. Graham, W.S., Andrew Thomson, Alexander Mitchell, junr., Robert Graham, Andrew Oswald Mitchell, Henry Wardrop, Thomas Kyle, Robert Pattison, John Tennant, and Charles James Tennant, were admitted as members. The three following papers were then communicated by Dr. R. D. Thomson:—

XXV.—*Experiments on various Manures.* By LORD BLANTYRE.

TABLE I.

Experiments with Oats at West Harlands, Renfrewshire, ¼ Imperial Acre each plot.

No. of Lot.	APPLICATION.	Weight of Straw in Pounds.	Produce of Grain (good.)		Weight per Bushel.	Light.	Increase of Straw.	Increase of Grain.		Ashes in 1000 grains.
			bsh.	lbs.	lbs.	lbs.	lbs.	bsh.	lbs.	
1	No application.	717	12	10	41	10½	...	...	...	28.3
2	Turnbull's Humus, 10 bushels, @ 1s.	644	11	8½	41	11½	...	...	...	...
3	Improved Bones, 56 lbs. 6s. per cwt.	675	11	2	41	10½	...	...	...	26.6
4	Sulph. of Soda, 56 lbs. 6s. per cwt.	762	12	...	40	14½	45	...	...	29.42
5	Foreign Guano, 28 lbs. 25s. per cwt.	768	12	4	41½	6½	51	...	...	32.75
6	Sul. Ammo. 28 lbs. 20s. per cwt.	770	12	22	40	10	53	...	12	...
7	British Guano, 56 lbs. 8s. per cwt.	788	12	17½	41½	10½	71	...	7½	27.76
8	Soot, 10 bushels, @ 3½d.	880	13	30½	41	9½	163	1	20	...
9	Nit. of Soda, 28 lbs. @ 25s. per cwt.	908	12	21	42½	8	191	...	11	28.6

REMARKS.—The Grain of No. 1. passed through the hummeler, which seems to have increased the weight per bushel 2½ lbs.
The weight of the Light Corn was 29½ lbs. per bushel.

Note.—The last column in this table was deduced from the experiments of Mr. Michelmore and Mr. Watson, made in the University Laboratory.—R. D. T.

TABLE II.

Experiments on Potatoes with Manures over dung, each plot ¼ Imperial Acre.

		Produce.				Increase.			Value of Increase.	
		tons	cwt.	qr.	lb.	cwt.	qr.	lb.		
1. Nothing.	cost 0s 0d	2	19	0	7	0	0	0	0s.	0d.
2. Soot, . . . 7½ bsh.	... 2s 6½d	2	15	3	21	0	0	0	0s.	0d.
3. Gypsum, . .	...	2	18	1	21	0	0	0	0s.	0d.
4. { Sulp. of Soda, 28 lbs. } { Sul. of Amm., 14 lbs. }	... 4s 0d	2	19	0	24½	0	0	17½	0s.	3½d.
5. Imp. Bones, (Turnbull's)	... 3s 0d	2	19	2	21	0	2	14	1s.	3d.
6. Artifi. Guano, 56 lbs.	... 4s 0d	2	19	2	21	0	2	14	1s.	3d.
7. For. Guano, 28 lbs.	... 6s 3d	3	0	0	0	0	3	21	1s.	10½d.
8. { Sulp. of Soda, 28 lbs. } { Nit. of Soda, 14 lbs. }	... 4s 7½d	3	0	1	24½	1	1	17½	2s.	9¾d.

The column on the right side is the value of the increased produce, calculated at 10s. a boll, Renfrewshire measure, or 40s. a ton—a Renfrewshire boll of potatoes being exactly 5 cwt.

TABLE III.

Experiments on Wheat at Erskine, 1842, per ¼ Imperial Acre.

APPLICATION.	Cost of Application.		Straw.	Increase of Straw.	Grain.		Weight per Bushel.	Grain Increase.	
	s.	*d.*	lbs.	lbs.	bsh.	lbs.	lbs.	bsh.	lbs.
1. Soot, ... 10 bsh.	2	11	1213	205	13	33	58	2	32
2. Turnbull's Humus, 10 bsh.	10	0	1055	47	12	48	60	1	47
3. Do. Imp. Bones, . 56 lbs.	3	0	973	...	11	58	62	...	57
4. Do. British Guano, 56 lbs.	4	0	1193	185	14	43	61	3	42
5. Foreign Guano, . 28 lbs.	6	3	1049	41	11	34½	61½	...	33½
6. No appplication.	...		1008	...	11	1	62	...	...
7. Sulph. of Soda, . 56 lbs.	3	0	1073	65	13	7	62	2	6
8. Sulph. of Ammo., 28 lbs.	5	0	1138	130	13	38	62	2	37
9. Nitrate of Soda, . 28 lbs.	6	3	1159	151	13	38	62	2	37

XXVI.—*Results of Experiments with Manures on Potatoes.* By MR. DUGALD DOVE, *Nitshill.**

THE field in which the following experiments were made was furrow-drained about eight years ago; had been cropped for a long series of years, and was in poor condition. The upper soil is a sandy loam,

* This paper forms the result of a successful competition for a premium of £5, offered by John Wilson, Esq., of Aucheneaden, to the Renfrewshire Agricultural Society.

with a close, retentive, cold, tilly bottom or subsoil; the ground was wrought in the usual manner—the drills being twenty-eight inches from centre to centre.

The soot was damped with water; the sulphate of ammonia was reduced to a fine powder; the farm-yard manure was spread in the drills, and the other manures on the top or along with it; the lot with the soot had a sprinkling of earth between the manures and the setts. They were all covered up immediately with the plough. The length of the drills was 694 links, by 38 links for each lot, making 42⅓ falls, all Scotch measure. The guano cost 15*s.* per cwt.; the sulphate of ammonia, 20s. per cwt.; the soot, 1*s.* 1*d.* per boll; the bone-dust, 3*s.* per bushel; and the farm-yard manure, 7*s.* per ton, on the ground. The following table shows the lots, manures, weight of manures, cost, and produce, per old Scotch acre, the produce being estimated in Renfrewshire bolls, of 5 cwt. to the boll:—

Application.					Cost per Acre.						Produce.		For every £1 of Manure.	
Lots.		tons	cwt.	qr.	£	*s.*	*d.*	£	*s.*	*d.*	Bls.	Pks.	Bls.	Pks.
1.	Guano, .	0	4	0	3	0	0							
	Dung, . .	8	10	0	2	19	6	5	19	6	33	1	5	8½
2.	Sul. of Am.,	0	3	0	3	0	0							
	Dung, . .	8	10	0	2	19	6	5	19	6	31	3	5	3½
3.	Bone Dust,	20 bushels.			3	0	0							
	Dung, . .	8	10	0	2	19	6	5	16	6	33	1	5	8½
4.	Soot, . .	55½ bolls.			3	0	0							
	Dung, . .	8	10	0	2	19	6	5	19	6	27	10¼	4	10

It will be observed that lots 1st and 3d produced the same quantities, viz., 5 bolls, 8½ pecks, for every £1 worth of manures made use of; lot 2d, 5 bolls 3½ pecks; and lot 4th, 4 bolls 10 pecks, for every £1 worth; £5 : 19 : 6 being the amount laid out per acre on all the lots. Lot 1st was ready for digging three weeks, and lot 3d, two weeks, before lots 2d and 4th. There were few failures of the seed in lots 1st and 3d, while in lot 2d about two-fifths of the seed failed, and in lot 4th about three-fifths, or fully the one-half. All the lots were planted with smooth red potatoes, on the same day and under the same circumstances. I did not make up the deficiences where the seed failed, conceiving that it was of as much importance to the grower to know the manure which had a tendency to destroy the seed, as the one producing the greatest quantity. I am satisfied that lots 1st and 3d were under-manured, and that lots 2nd and 4th were over-manured. These two last continued to grow, with a strong dark green leaf, till subsequently nipped by the frost. The potatoes from them were very large—some of them weighing upwards of 1 lb., and several of the shaws producing upwards of 4 lbs. of potatoes. All the lots were of first rate quality. The potatoes grown with the guano were a peculiarly richly flavoured dry mealy potatoe; the potatoes from the sulphate of ammonia a fine dry mealy potatoe; the potatoes from the bone-dust similar; and those from the soot very good, but if any thing, inferior to the other two.

In addition to the foregoing, I tried in the same field, and to the same extent of ground, that is, 42½ falls, potatoes, with soot, guano, bone-dust, sulphate of ammonia, and farm-yard manure, separately. The following table shows the weight of manure, cost, and produce, per acre, Scots measure:—

Lots.	Manures.	Weight.			Cost.			Produce.	
		tons	cwt.	qr.	£	*s.*	*d.*	Bls.	Pks.
1.	Guano, ...	0	4	0	3	0	0	13	13
2.	Sulphate of Ammon.	0	3	0	3	0	0	11	1
3.	Bone Dust, . . .	20 bushels.			3	0	0	10	10
4.	Soot, ...	36 bolls.			1	19	0	13	3½
5.	Farm-yard Manure,	8	10	0	2	19	6	31	8½

The potatoes from the guano and bone-dust were small, and had a weak shaw; those from the soot and sulphate of ammonia possessed a fresh, strong, healthy shaw, and were of ordinary size. The failures were in the same proportion as in the experiments with the mixture of dung; but there were no failures when the potatoes were planted with farm-yard manure alone; the quality of the potatoes from the guano and farm-yard manure was good; the quality from the soot, ammonia, and bone-dust bad. The failures in the seed in these experiments were not made up. The subsoil where the last five lots were planted, was of an open sandy nature, and the upper soil deeper than where the first four lots were planted.

Note.—In the experiments detailed in the two preceding, and in the following papers, the results are so varied, probably from the nature of the season, that the conclusions to be deduced are not important. They seem to favour the idea, however, that saline substances, as they have been applied in these experiments, are not capable of superseding farm manure or night soil altogether—inasmuch as the crop for the first year appears generally to be more prolific when the latter is also present. It remains, however, to be determined if the influence of these manures is of a more permanent nature than that of farm manure—and the promised continuation of experiments of Mr. John Wilson, by whose desire Mr. M'Lintock's trials were made, will undoubtedly throw light on this subject.—R. D. T.

XXVII.—*Experiments with Manures on Oats and Turnips*—1842. By MR. WILLIAM M'LINTOCK, *Hurlet.*

Experiments with Manures on Oats.

No. of Lots.	MATERIALS APPLIED.	Size of Lots.	Value of Application.	PRODUCE. Grain.	Straw.	Chaff.	Total Produce.
				lbs.	lbs.	lbs.	lbs.
1	14 lbs. Sulphate of Ammonia,	Each lot measured 20 falls, or ⅛ of an Acre Scotch.	Value of material applied to each lot 2s. 6d. or at the rate of 20s. per Acre Scotch.	224	336	30	590
2	13 lbs. Muriate of Ammonia,			252	394	40	686
3	12 lbs. Nitrate of Ammonia, .			273	454	56	783
4	Nothing applied to this lot,			179	259	38	476
5	50 galls. Ammo. Water from Gas Works, mixed with dry ashes, ...			228	337½	40	605½
6	70 lbs. British Guano, . . .			202	315	42	559
7	35 lbs. Rape Cake in powder,			217	304	40	561
8	⅜ of a bushel fine Bone Dust,			200	274	37	511
9	1½ bolls Soot, ...			231	315	42	588
10	20 lbs. Foreign Guano, . . .			212	292½	39	543½
11	11 lbs. Nitrate of Soda, . .			220	360	44	624
12	12 lbs. Nitrate of Potash, . .			301	495	40	836
13	20 cwt. St. or Police Manure,			259	391½	41	691½

Note.—The soil on which the above trials were made is a stiff clay, and has not been drained. The materials were all applied shortly after the oats had brairded, on 13th May, and the oats were reaped on 15th August. Lot No. 5 failed, it is supposed, in consequence of the extreme dry and warm season. The oats on lots No. 4 and 10 were of inferior quality, and weighed only 36 lbs. per bushel, whereas the oats from the other lots weighed 40 lbs. per bushel.

The ground on which these trials were made has been sown with grasses, which are looking well; in particular, on the lots where Ammoniacal applications have been made. It is intended that the produce of hay from each lot shall be carefully weighed next season.

Note by Dr. R. D. Thomson.—The following is the result of an analysis of the soil upon which the preceding experiments were made —500 grains were analysed, and the methods employed were similar to those I have elsewhere described.

	In 500 grs.	1000 grs.
Silica, ...	265·90	531·80
Alumina, ...	75·10	150·20
Water from decomposed soil, ...	79·60	159·20
Carry forward, ...	420·60	841·20

		In 500 grs.	1000 grs.
Brought forward,		420·60	841·20
Organic matter, containing about 8 grains Carbon, and 2 of Azote, and Water from undecomposed soil,		39·00	78·00
Peroxide of Iron and Phosphates.	Peroxide of Iron, 21·09; Phosph. of Iron, 3·80; Phosph. of Lime, 0·20; Phosph. of Alumina, 0·10	25·19	50·38
Chlorides of Potassium and Sodium of decomposed soil,		0·50	1·00
Magnesia,		2·10	4·20
Loss,		12·61	25·22
		500·00	1000·00

Experiments on Turnips.

No. of Lots.	Manures Applied.	Size of Lots.	Value of Manure.	Produce. cwt.	qr.	lb.
1	21 cwt. Mixt. of Ashes and Night Soil,	10 falls.	3s. 6d.	10	2	14
2	24 lbs. Foreign Guano, ...	Do.	Do.	8	0	0
3	20 lbs. Sulphate of Ammonia, . .	Do.	Do.	8	1	21
4	1⅛ bushels of Bone Dust, ...	Do.	Do.	8	1	0
5	11 bushels Soot, ...	Do.	Do.	4	3	21
6	98 lbs. British Guano, ...	Do.	Do.	7	3	0
7	49 lbs. Rape Cake in powder, . . .	Do.	Do.	9	0	14
8	16 lbs. Nitrate of Soda, ...	Do.	Do.	3	3	14
9	16 cwt. Ashes & Night Soil, 2s. 8d.; 5 lbs. Sulphate Ammonia, 10d.	Do.	Do.	16	2	7

Dr. Anderson, jun., gave an account of the recent researches on Secretion by Messrs. Goodsir and Bowman.

1*st February*, 1843.—*The* President *in the Chair.*

Messrs. William Craig, Peter M'Onie, A. D. Anderson, Wm. Gale, William Strang, and George Gardner, F.L.S., were admitted as members. The following papers were read:—

XXVIII.—*On the Manner in which Cotton unites with Colouring Matter.* By Walter Crum, Esq.

The effect of porous bodies in producing combination and decomposition, independently of chemical affinity, has of late years occupied considerable attention.

If we examine, says Professor Mitscherlich, a piece of boxwood by the microscope, we find it composed of cells, which have a diameter of about $\frac{1}{2400}$th of an inch. Heated to redness, the form of these cells suffers no change, for the particles of which it is composed have no tendency to run together in fusion. A cubic inch of boxwood charcoal, boiled for some time in water, absorbed $\frac{5}{8}$ths of its volume of that liquid; from which, and other data, it was computed that the surface of its pores was 73 square feet.

Saussure observed, that a cubic inch of boxwood charcoal absorbed 35 cubic inches of carbonic acid; and as the solid part of the charcoal formed $\frac{3}{8}$ths of its bulk, these 35 inches of gas must have been condensed into $\frac{5}{8}$ths of an inch; or 56 cubic inches into one, under the ordinary pressure of the atmosphere. But carbonic acid liquefies under a pressure of 36·7 atmospheres; and therefore, with a power of condensation equal to 56 atmospheres, which the charcoal exerted in Saussure's experiment, at least one-third of the gas must have assumed the liquid state within its pores. Every other porous body has the same property as charcoal. Raw silk, linen thread, the dried woods of hazel and mulberry, though they condense but a small quantity of carbonic acid, take up from 70 to 100 times their bulk of ammoniacal gas; and Saxon hydrophane, which is nearly pure silica, absorbs 64 times its bulk. The gases enter into no combination with the solid which absorbs them, for the air pump alone destroys their union.

The manner in which gases are attracted to the surface of solid bodies is very much like that which these exert on substances dissolved in water. The charcoal of bones has been long employed to remove colouring matter from the brown solution of tartaric acid; from syrup in the refining of sugar; and from a variety of other liquids containing organic substances; and it is found that the colouring matter so attracted remains attached to the surface of the charcoal without effecting any change upon it. In this animal charcoal the carbon is mixed with ten times its weight of phosphate of lime, and if that be washed away by an acid, the remaining charcoal has nearly twice the discolouring power of an equal weight of ivory black. Bussy, who has made the action of these charcoals the subject of particular investigation, informs us, that if ivory black, after the extraction of its earth of bones by an acid, be calcined along with potash, and the potash be afterwards washed out; or if blood be at once calcined with carbonate of potash, and washed, the remaining charcoal has the power of discolouring twenty times as much syrup as could be done by the original bone charcoal. Animal charcoal removes also lime from lime water; iodine from a solution of iodide of potassium, and metallic oxides from their solution in ammonia and caustic potash.

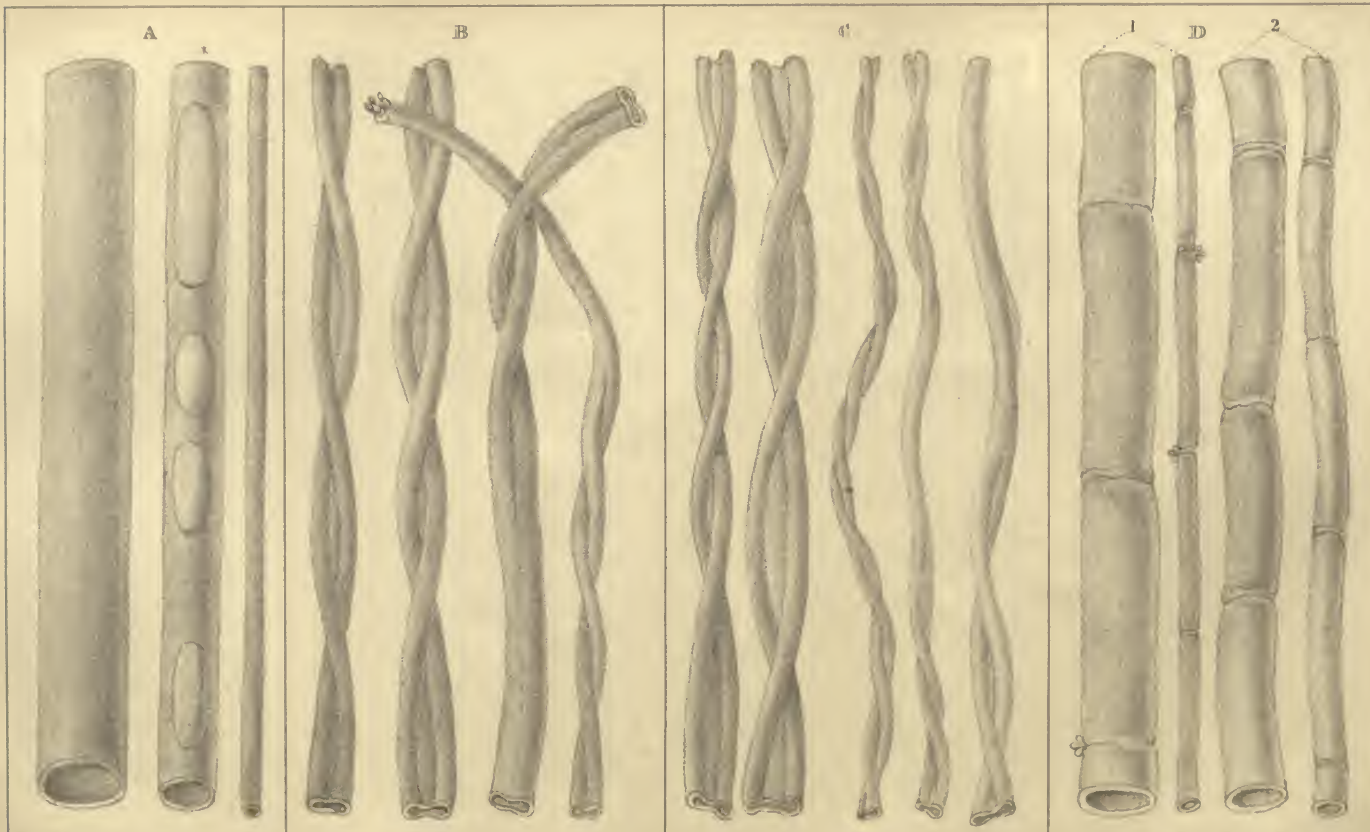
A satisfactory explanation of these remarkable facts has yet to be sought for. Mitscherlich calls the force which produces them an action of contact, or attraction of surface; and he calculates, as we have seen, the extent of surface in proportion to the mass, as the measure of the force which it exerts. On the other hand, Saussure, in his valuable paper on the Absorption of Gases, informs us, that charcoal from boxwood, in the solid state, absorbs twice as much common air as when it is reduced to powder. Now, the effect of pulverization is certainly not to diminish the extent of surface. Saussure accounts for it in another way, and his explanation seems to connect many of the facts. The condensation of gases in solid charcoal goes on, he conceives, in the narrow cells of which it is composed, and is analogous to the rise of liquids in capillary tubes. In both, he says, the power appears to be in the inverse ratio of the size of the interior diameters of the pores or tubes of the absorbing bodies. When we pulverize a body containing such cells, we widen, open, and destroy them. Fir charcoal, whose cells are wide, absorbs 4½ times its bulk of common air, and boxwood charcoal, with smaller pores, takes 7½. Charcoal from cork, with a specific gravity of only 0·1, absorbs no appreciable quantity.

It appears to me that many of the operations of dyeing depend upon this influence of the surface, or the capillary action described by Saussure. The microscopic examination of the fibres of cotton by Mr. Thomson of Clitheroe, and Mr. Bauer, shows them to consist of transparent glassy tubes, which, when unripe, are cylindrical; and in the mature state, collapsed in the middle, from end to end; giving the appearance of a separate tube on each side of the flattened fibre. As the sides of these tubes permit the passage of water, they also must be porous; but the form, or even the existence of such lateral perforations, cannot be detected by the most powerful microscope.

In many of the operations of dyeing and calico-printing, the mineral basis of the colour is applied to the cotton in a state of solution in a volatile acid. This solution is allowed to dry upon the cloth, and in a short time the salt is decomposed, just as it would be, in similar circumstances, without the intervention of cotton. During the decomposition of the salt its acid escapes, and the metallic oxide adheres to the fibre so firmly as to resist the action of water applied to it with some violence. In this way does acetate of alumina act; and, nearly in the same manner, acetate of iron. The action here can only be mechanical on the part of the cotton, and the adherence, as I shall endeavour to show, confined to the interior of the tubes of which wools consist, or of the invisible passages which lead to it. The metallic oxide permeates these tubes in a state of solution, and it is only when its salt is there decomposed, and the oxide precipitated and reduced to an insoluble powder, that it is prevented from returning through the fine filter in which it is then enclosed.

When the piece of cotton, which, in this view, consists of bags lined inside with a metallic oxide, is subsequently dyed with madder or logwood, and becomes thereby red or black, the action is purely one of chemical attraction between the mineral in the cloth, and the organic

MAGNIFIED FIBRES OF COTTON & FLAX



Francis Bauer, del. Kew Green.

Maclure & Macdonald Lith. Glasgow

matter in the dye vessel, which, together, form the red or black compound that results; and there is no peculiarity of a chemical nature from the mineral constituent being previously connected with the cotton. The process of cleansing in boiling liquids, and in the wash wheel, to which cotton, printed with the various mordants, is subjected, previous to being maddered, is to remove those portions of metallic oxide which have been left outside the fibres, or got entangled between them, and fastened there more or less firmly by the mucilage employed to thicken the solution.

The view I have now given is, in some respects, the old mechanical theory of dyeing held by Macquer, Hellot, and le Pileur d'Apligny, before the time of Bergman. Although unacquainted with the microscopic appearance of cotton, d'Apligny argued, that as no vegetable substance in its growth can receive a juice without vessels proper for its circulation, so the fibres of cotton must be hollow within. And of wool, he says, the sides of the tubes must be sieves throughout their length, with an infinity of lateral pores. We may gather, also, that he conceived dyeing to consist, first, in removing a medullary substance contained in the pores of the wool, and afterwards depositing in them particles of a foreign colouring matter.

But Bergman, in his Treatise on Indigo, in 1776, upset all this; and attributed to cotton a power of elective attraction, by which all the phenomena of dyeing were referred to purely chemical principles. Macquer soon adopted the chemical theory, and it was keenly advanced by Berthollet, who succeeded Dufay, Hellot, and Macquer, in the administration of the arts connected with chemistry. Berthollet has been followed by all, so far as I know, who have since that time written on the subject, but nothing like evidence has ever been produced; and, if we only consider that chemical attraction necessarily involves combination, atom to atom; and, consequently, disorganization of all vegetable structure; that cotton wool may be dyed without injury to its fibre, and that that fibre remains entire, when, by chemical means, its colour has again been removed, we shall find that the union of cotton with its colouring must be accounted for otherwise than by chemical affinity. In particular processes, as we shall afterwards see, attraction is no doubt exerted, but it is an attraction connected with structure, and therefore more mechanical than chemical.

When we examine, with a powerful microscope, a fibre of cotton, dyed either with indigo, with oxide of iron, chromate of lead, or the common madder red, the colour appears to be spread so uniformly over the whole fibre that we cannot decide whether the walls of the tube are dyed throughout, or that the colouring matter only lines their internal surface. But the microscope shows that the collapsing which occurs in raw and bleached cotton, is very considerably diminished in the dyed.

The greater number of specimens of Turkey red which I have examined show the same uniformity of colour; but in others of them little oblong balls appear all along the inside of the tube, of the fine pink shade of that dye, while the tube itself is colourless. But I shall resume these observations with a more perfect instrument, which I hope soon to possess.

We have, moreover, the powerful analogy of the arrangement of colouring matter in plants, in support of this view of the case. "Cellular tissue," says Dr. Lindley, in his Introduction to Botany, "generally consists of little bladders or vesicles of various figures, adhering together in masses. It is transparent, and, in most cases, colourless; when it appears otherwise, its colour is caused by matter contained within it." "The bladders of cellular tissue are destitute of all perforations, so far as we can see, although, as they have the power of filtering liquids with rapidity, it is certain that they must abound in invisible pores." "The brilliant colours of vegetable matters, the white, blue, yellow, scarlet, and other hues of the corolla, and the green of the bark and leaves, is not owing to any difference in the colour of the cells, but to the colouring matter of different kinds which they contain. In the stem of the Garden Balsam, a single cell is frequently red in the midst of others which are colourless. Examine the red bladder, and you will find it filled with a colouring matter of which the rest are destitute. The bright satiny appearance of many richly coloured flowers depends upon the colourless quality of the tissue. Thus, in *Thysanotus fascicularis*, the flowers of which are of a deep brilliant violet, with a remarkably satiny lustre, that appearance will be found to arise from each particular cell containing a single drop of coloured fluid, which gleams through the white shining membrane of the tissue, and produces the flickering lustre that is perceived." Cotton is itself cellular tissue; and the ligneous basis of all the forms of these vessels has the same chemical constitution.

I have alluded to another class of processes in dyeing where the action much more resembles chemical affinity. I mean that in which pure cotton, by mere immersion in different liquids, withdraws a variety of substances from their solution. The indigo vat is a transparent solution of a brownish yellow colour, consisting of deoxidized indigo combined with lime, and containing seldom more than $\frac{1}{500}$ of its weight of colouring matter. By merely dipping cotton in this liquid, the indigo attaches itself to it in the yellow state, in quantity proportioned, within certain limits, to the length of the immersion; and all that is necessary then to render it blue is to expose it to the air. Here an indifferent spongy substance exercises a power which overcomes chemical affinity; but the mixture which is formed of cotton and indigo possesses none of the characters of a chemical compound. We can only recognise in this action the same force, whatever that may be, which enables animal charcoal to discolour similar liquids. Charcoal, as we have also seen, withdraws metallic oxides from their solution in alkalies. Cotton wool has the same power, and it is extensively used, as a means of dyeing with the yellow and red chromates of lead. If lime in excess be added to sugar of lead, dissolved in a considerable quantity of water, the lead which precipitates is redissolved in the lime water, and forms a weak solution of plumbate of lime. If a piece of cotton be immersed in this solution, it appropriates the lead, and when afterwards washed and dipped in a solution of chrome, the lead becomes chromate of lead.

The same force enables cotton to imbibe basic salts of iron and tin by immersion in certain solutions of these metals; and many other examples of what Berzelius calls a catalytic force, in decomposing weak combinations, will occur to those who are familiar with the art of dyeing.

It appeared to me interesting to compare the amount of surface exposed by cotton wool, with that of the more minute divisions of charcoal. I am enabled to give the following calculations through the kindness of Professor Balfour, who has furnished me with the necessary microscopic observations. The fibre of New Orleans wool varies most commonly from $\frac{1}{1500}$ to $\frac{1}{2000}$ of an inch in diameter. About 40 of these fibres or tubes compose a thread of No. 38 yarn, (38 hanks to the pound.) Ordinary printing cloth has, in the bleached state, 493 lineal feet of fibre, or 10·6 square inches of external surface of fibre in a square inch, which weighs nearly 1 grain. It is easy to compress 210 folds of this cloth into the thickness of one inch. It has then a specific gravity of 0·8. One cubic inch has 94163 lineal feet of tube, and 16·8 feet of external, surface; or, if we include the internal surface, there are upwards of 30 square feet of surface of fibre in one cubic inch of compressed calico. The charcoal of boxwood has, as we have seen, 73 square feet of surface to the inch, with a specific gravity of 0·6.

Explanation of the Plate.

It is copied from the paper of Mr. James Thomson on the Mummy Cloth of Egypt, Philosophical Magazine, June, 1834. The drawings were made, at Mr. Thomson's desire, by Mr. Bauer of Kew, the most accurate delineator of microscopic objects that has ever appeared. The figures represent $\frac{1}{100}$ of an inch in length, and are magnified 400 times in diameter.

A. Fibres of the unripe seed of cotton. In that state the fibres are perfect cylindrical tubes. At * is a fibre represented as seen under water, showing that the water had gradually entered, and enclosed several air bubbles; proving the tube to be quite hollow and without joints. If separated from the plant in the unripe state, these fibres do not afterwards twist.

B. Fibres of ripe cotton, both before and after the bursting of the pod or capsule.

C. Various fibres of unravelled thread of manufactured cotton.

In thickness these fibres vary from $\frac{1}{800}$ to $\frac{1}{3600}$ part of an inch. The twists or turns in a fibre of cotton are from 300 to 800 in an inch.

D. Fig. 1. Fibres of raw flax before spinning.

Fig. 2. Fibres of unravelled thread of manufactured flax.

The elementary fibres of flax are also transparent tubes, cylindrical, and articulated, or jointed like a cane. This latter structure is only observable by the aid of an excellent instrument. These fibres vary in thickness from $\frac{1}{800}$ to $\frac{1}{3800}$ part of an inch.

XXIX.—*On a Specimen of Artificial Asbestus.*

By F. PENNY, *Ph. D., Professor of Chemistry in the Andersonian University.*

FOR a specimen of this substance, I am indebted to Mr. William Murray of Monkland; and, for a very accurate analysis of it, to his son, Mr. Francis Murray.

It was found in a Blast Furnace, embedded in the mass of matter which had collected at the bottom of the furnace in the course of 2½ years, and which is technically called the hearth; it was in a cavity, about 8 inches below the level on which the liquid metal rested, and was interspersed with distinct and beautiful crystals of Titanium.

In all its general characters, this substance corresponds with Asbestus. It is colourless, inodorous, and tasteless—and occurs in small masses, composed of extremely minute filaments or fibres, cohering longitudinally together. These fibres are very easily detached from each other—and are flexible, though not so much so as the common Asbestus. They have a silky lustre, and are unattacked by sulphuric, nitric, or muriatic acid. They remain unchanged in the flame of a spirit lamp, and are difficultly fusible even with the blowpipe.

A preliminary examination having been made to ascertain the ingredients contained in the substance, 10 grains of the longest and cleanest of the fibres were selected for analysis. This was the largest quantity that could be obtained free from adventitious matter. The process adopted was the one usually recommended for the analysis of insoluble siliceous minerals. The following are the results per cent.:—

Silica, ...	72·5
Alumina, ...	9·0
Protoxide Manganese, . .	13·2
Magnesia, ...	2·0
Lime, ...	1·58
Iron, ...	2.65
	100·93

On comparing the above with the analyses that have been given of the several varieties of Asbestus, we remark, that the artificial specimen contains about 10 per cent. more silica, and that magnesia, of which there is 25 per cent. in natural Asbestus, is replaced by the protoxide of manganese. Now, it is well known that the protoxide of manganese is isomorphous with magnesia, and hence this replacement of the one by the other is at once explained. I apprehend the substitution of manganese for magnesia will be found much more frequent in the mineral kingdom when minerals are submitted to improved methods of analysis. The occurrence of Asbestus in an iron furnace affords a beautiful proof of the igneous origin of this substance.

XXX.—*Notice of New Zealand Minerals.*

Dr. R. D. Thomson showed a specimen of Phosphate of Iron, or native Prussian blue, from New Zealand, presented to him by Dr. Ernst Dieffenbach, Naturalist to the New Zealand Company, which had been analysed in the University Laboratory, at his request, by Mr. Robert Pattison. Its constituents were—

Water,	28·4
Organic matter,	2·8
Silica,	5·2
Phosphate of Iron,	62·8
	99·2

Dr. Thomson also exhibited a deposit from a hot spring in the interior of the same island, which Mr. Pattison found to have a specific gravity of 1·968, and to consist of—

Silica,	77·35
Alumina,	9·70
Peroxide of Iron,	3·72
Lime,	1·54
Water,	7·66
	99 98

From the statement of Dr. Dieffenbach, it appears that the greater part of the interior of New Zealand is of a volcanic nature, and abounds in hot springs.

15th February, 1843,—*The* PRESIDENT *in the Chair.*

Messrs. Andrew Craig, John Heugh, and George Wilson, were admitted members.

The following communication was read:—

XXXI.—*Notice of the Fossil Plants in the Glasgow Geological Museum.* By WILLIAM GOURLIE, Jun. Esq.

MOST of the members of this Society are aware, that previous to the meeting of the British Association in Glasgow a Committee was appointed to make a collection of the minerals, rocks, and organic remains of the west of Scotland. Through their exertions, and with the kind and zealous co-operation of many noblemen and gentlemen connected with the mining districts, a collection was formed, which in point of geological interest has not been equalled at any meeting of the Association, and which was a source of much gratification to M. Agassiz, Mr. Murchison, Sir H. T. De la Beche, Mr. Lyell, and the other distinguished geologists who honoured this city with a visit on that occasion. Although a part of that temporary museum was merely lent by various local collectors, by far the greater part remains in the possession of the committee appointed to take charge of it, at a meeting held in April, 1841, for concluding the transactions connected with the meeting of the British Association.

In the mean time, the collection is stored in rooms rented from the Andersonian Institution, and is only partially laid out, as the Committee have not considered it expedient to attempt the formation of a Geological museum, on a scale worthy of the city of Glasgow, until the recurrence of more propitious times. Having had the pleasure of assisting Dr. Scouler in the arrangement of the museum of 1840, and been since associated with my friend Dr. Colquhoun in carefully preserving the specimens, I have drawn up a short notice of the vegetable remains in the collection, a department which is attractive not only to the scientific student of nature, but also to the popular enquirer, and which, I trust, will not be altogether uninteresting to the Society.

These organic remains consist of plants, fishes, shells, and zoophytes. For obvious reasons, they are chiefly from the limestones, shales, and sandstones of the carboniferous group of rocks, which extend upwards from the old to the new red sandstone, and include the *mountain limestone*, abounding in shells and corals,—the *millstone grit*, which occurs principally in South Wales and Yorkshire, but which is often absent,—and the *coal measures*, which are absolutely packed with the remains of extinct genera of plants, molluscous animals and fishes.

These coal measures, again, consist of a vast series of marine and fresh-water limestones, sandstones, beds of coal of various thickness and quality, indurated clay, ironstones, all the varieties of which are carbonate of protoxide of iron, and soft argillaceous beds, which being of a slatey structure, are generally called shales. The series above enumerated is frequently repeated,—in some coal fields reaching a thickness which has been estimated at nearly 6000 feet. Mr. Murray of Monkland has found the whole thickness in the Lanarkshire coal field to be at least 357 fathoms, or 2142 feet, as detailed in an interesting section, which he communicated to the Society at the conclusion of this paper.

The following is a brief notice of some of the genera of fossil plants which were amply illustrated by specimens from the collection, a catalogue of which is given at the end of this paper:—

Calamites.—The fossil plants referable to the genus *Calamites* of Brongniart, and other authors, occur profusely in our coal fields, as well as in those of the north of England. They are found in a state of compression, which renders it difficult to determine their species, or to form an idea of their probable affinity to plants of the present day. Judging from the remarkable compression of even the largest specimens, it is likely that the calamite had a hollow jointed stem, with transvere phragmata, resembling that of the bamboo cane, and, at least in some species, with verticillate branches, which again have verticillate leaves. Brongniart thinks that the calamites must have had a close affinity to the recent genus *Equisetum*, from their striated, or rather furrowed, jointed stems, and the presence in one of his specimens of what he takes to be a sheath; but the objection to this view is, that they appear to have had both wood and bark, and consequently with the habit of a monocotyledonous plant, they come nearer the dicotyledones in structure. A specimen from the Duke of Hamilton in this collection was found in the sandstone in an upright position, and shows the form of the stem without the usual compression; but it is apprehended, that even were it possible to form a thin polished section, it would exhibit no trace of structure.

Sigillaria.—A number of specimens in the museum belong to the genus *Sigillaria*, so named from *sigillum*, a seal, on account of the peculiar impressions on the stems. Less is known of this genus than even the calamites, and similar forms are quite unknown in the vegetation of the present day. They are found inclined in all directions, sometimes passing vertically through beds of sandstone, but most frequently in a horizontal position, and then they are crushed so extremely thin, that they seem to have been hollow like the calamite, and to have possessed very little substance, although attaining a height of forty or fifty feet. The compressed stems have been found as much as five feet in breadth, and some fragments now produced, particularly a portion of *S. reniformis*, must have belonged to a very large individual. They are generally fluted longitudinally, and marked at regular intervals with single or double scars, evidently produced by leaves which have been articulated to the stem. These marks are different in the decorticated state of the fossil from those which appear on the surface of the coaly envelope representing the bark; this is well seen in the *Sigillaria reniformis*. M. Brongniart considers these to be remains of the stems of arborescent ferns; but we incline to the view of Messrs. Lindley and Hutton, who have established that the fluted *Sigillariæ* have nothing analogous to tree ferns. On the contrary, they appear to have been plants with hollow cylindrical stems, consisting of wood and bark, and clothed with leaves—attaining a height of forty to sixty feet—but belonging to a family with no representative, or even relation, in the flora of our day.

Lepidodendron.—This genus of fossil plants is one of great interest, not only on account of its abundance, and the elegance and beauty of its impressions and casts, but from the affinity between the fossil Lepidodendron and two existing genera of plants. In the first volume of the "Fossil Flora," by Dr. Lindley and Mr. Hutton, the authors express their belief that the Lepidodendra would be found to be intermediate between the *Coniferæ* and *Lycopodiaceæ* of the present day. The first of these natural orders, the *Coniferæ*, comprehends the pines, larch, cedar, &c. The *Lycopodiaceæ*; on the other hand, are small in size compared with either the *Lepidodendra* or the *Coniferæ*, and a few species are indigenous to this country, where they are familiarly known as Club-mosses. The opinion referred to has been confirmed by subsequent investigations. Some of the specimens of this genus contributed to the collection are of singular beauty, and the attention of the Society was particularly directed to specimens of *L. elegans*, from C. J. Baird, Esq., of Shotts Iron-work. A group of "restorations" was also represented in a drawing, for the purpose of conveying some idea of the probable appearance of this genus of plants.

Lyginodendron Landsburgii, Gourlie.—A most remarkable cast of a plant was lately sent to me by the Rev. David Landsborough, which was found in a quarry of carboniferous sandstone at Stevenston, Ayrshire. The specimen when found had a coating of coal, which the quarryman unfortunately picked off with his knife, but the exposed surface presents a very singular appearance, and is unlike any fossil plant which we have ever seen figured. Its peculiar feature, which is at once apparent on inspection, is its resemblance to part of a common osier basket. Hence Mr. Landsborough has for some time been in the habit of humorously distinguishing it as "Noah's Creel," for want of a better name. To supply this desideratum in nomenclature, and as no such fossil appears to have been described or figured, I have ventured to name it *Lyginodendron Landsburgii*, forming the generic name from λυγινος, wicker-work, and δενδρον, a tree, and dedicating it by the specific name to my friend Mr. Landsborough, a gentleman who is distinguished not only as a pious and conscientious parish minister, but as an enthusiastic and most successful cultivator of natural history,—one, too, whose warm-hearted and amiable disposition endears him to all who have the pleasure of his acquaintance. The fragments of the fossil were spread over a space of about two yards, the finest specimen found being about eighteen inches in length, by three in breadth, and have not been observed except in that place. In the same quarry a great many fossil fruits occur, which are obviously those of a palm, and also specimens of *Sternbergia approximata*, a singular and rather rare coal plant. A fine specimen has been deposited in the museum of the Andersonian by Mr. J. Craig. The impressions of the fronds of ferns were also noticed as being extremely common in the shales and limestones of the coal formation, there being not fewer than 130 species known, nearly all of which belong to the tribe *Polypodiaceæ*.

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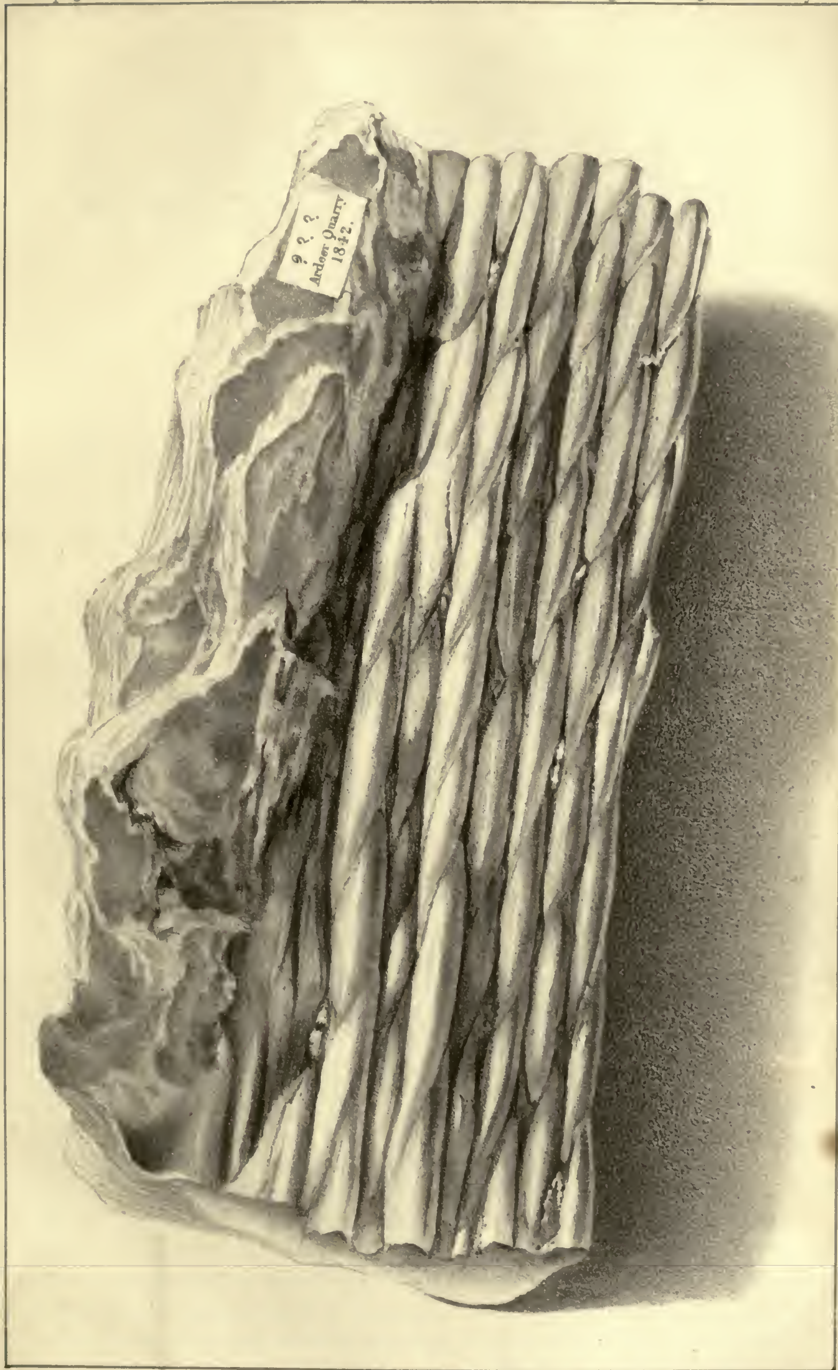


Maclure & Macdonald Lith.

LYGINODENDRON LANDSBURGII

Gourlie

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTY-FIRST SESSION, 1842-43.

CONTENTS.

15*th February,* 1843,—*The* President *in the Chair.*

XXXI.—*Notice of the Fossil Plants in the Glasgow Geological Museum.* By William Gourlie, Jun., Esq. (*Continued.*)

Coniferæ.—It is only lately that the remains of *Araucarias,* or trees similar to the Norfolk Island pines, have been identified in the coal strata, having previously been supposed to exist only in the secondary and tertiary series. From the examination of their polished sections, for the preparation of which Mr. Sanderson of Edinburgh is so celebrated, it is clearly ascertained that the Craigleith and Wardie fossil trees have been large *Araucarias,* as the peculiar structure of the pines of Norfolk Island, New Holland, or Brazil, is distinctly visible. The *Araucaria excelsa* bears the winters of the south of England and Ireland.

Stigmaria.—The last plant described in the paper, namely, the *Stigmaria,* was noticed as being the most extraordinary of all, and, in its form, mode of growth, and internal structure, quite *sui generis.* The *Stigmaria ficoides* is extremely abundant in the sandstones and shales, its almost semi-circular, grooved, and pitted arms extending themselves in all directions through the strata in which they are found. From a large central dome, probably growing in shallow water, a number of arms have radiated with great regularity, branching dichotomously, and extending to a distance of twenty or thirty feet, floating under the surface, and covered with long leaves, which appear to have been fistulose. In a specimen belonging to Dr. Smith of Crutherland, this hollow structure of the leaves is beautifully seen. We possess a fine specimen of a branch, ten feet in length, and a good specimen of the central dome may be seen in the Andersonian Museum. After quoting a description of the structure of the *Stigmaria* from the "Fossil Flora," this part of the paper was concluded with the observation, that as no plants of the present day have such a structure, *Stigmaria* represents a race now altogether extinct.

An important point of interest is the climate and atmosphere of the carboniferous epoch. That the immense plants of the coal lived and flourished during the prevalence of a high temperature, equal to, or perhaps greater than that of our torrid zone, is now generally believed. Brongniart has suggested that during the same period the atmosphere contained a much larger proportion of carbonic acid gas than it does now, which supplying abundance of food to the leaves of these plants, would greatly favour their development, and cause a rapid growth.

It has also been conjectured that the gigantic lizards, batrachian reptiles, and marsupial animals of former days may have been able to exist during this state of things,—that the horned *iguanodon* or long-necked *plesiosaurus* might inhale such an atmosphere with zest, and that the *megalichthys*, with its armorial covering of burnished enamel, may possibly have delighted to roam in *aerated* waters! Instead of indulging in theories which, however ingenious, seem to be somewhat extravagant and improbable, we would rather refer the phenomena observable in the coal formation to causes even now in operation, and agree with our President, Dr. Thomson, that "it is very hazardous to draw such conclusions, from the number and appearance of these plants, which, for anything we know to the contrary, may have been adapted for a colder climate, although analogous in some respects to those at present inhabiting torrid regions."*

The tropical flora of the present day, in many places, such as Southern India, Java, or Guiana, is probably more luxuriant than was that of the coal. Immense cities exist in Central America which have once been inhabited by races of people acquainted with the arts of civilized life, but which are now desolate, and buried in immense forests, often so thick and impervious that the light of day can hardly penetrate the mass of foliage. A rank and powerful vegetation has invaded the homes, altars, and palaces of this ancient people. Their immense and often beautifully sculptured idols or monuments are overturned by the expansion of roots, and bound down by enormous creeping and twining stems; and Mr. Stephens, in his intensely interesting account of them, tells us that the vegetative force has sometimes been so great as to lift large masses of masonry out of the earth, and almost heave them up in the air. Luxuriant and vigorous vegetation like this does not arise from heat alone, but from the com-

* Thomson's Outlines of Geology, vol. II. p. 260.

bined influence of heat and a humid atmosphere, in which respect I need hardly remind you that the arid sands and sterile rocks of Africa are not to be compared to the hills and dales of more temperate, but also more humid regions.* It has been suggested that in former ages the waters were more extensively distributed over the surface of the globe, and the moist atmosphere which would result, combined with a temperature much less than that of the torrid zone, would suffice to produce an abundant and rapid development of vegetable forms, without the aid of larger quantities of carbonic acid than we find in our present atmosphere. We do not know what kind of plants composed the great mass of the coal strata: equally ignorant are we of the capability which such plants as the lepidodendra or sigillariæ possessed of flourishing in a temperate climate. The occasional occurrence of an arborescent fern, or of a palm—for they are both extremely rare in the coal measures—does not furnish sufficient evidence of a hot climate, since such rivers as the Amazon or the Mississippi are probably at this moment depositing in their estuaries immense quantities of plants which may have been borne down in their waters for four or five thousand miles. The vast rivers of Siberia, two to three thousand miles in length, and the Mackenzie river of North America, carry down pines and other trees, with their roots attached, for many hundred miles, finally stratifying them in the Arctic Sea. Again, the larches and other pines of Norway or Great Britain are quite equal in size to any coniferæ which we find in the coal; and there are plenty of arborescent ferns in New Zealand in a latitude of nearly 46° south. It is well known that the great extent of ocean gives uniformity and mildness to the climate of the southern hemisphere, rendering the summers more cool, and the winters warmer, than they are in the same parallel of northern latitude. "Captain King observed large shrubs of *Fuchsia* and *Veronica*, which in England are treated as tender plants, thriving and in full flower in Terra del Fuego, (lat. 55° S.) with a temperature of 36°. He states also that humming-birds were seen sipping the sweets of the flowers after two or three days of constant rain, snow, and sleet, during which time the thermometer had been at the freezing point. Mr. Darwin also saw parrots feeding on the seeds of a tree called 'winter's bark,' south of latitude 55°, near Cape Horn."

* In a more recent work, viz., "Incidents of Travel in Yucatan," by J. L. Stephens, Esq., a sketch is given to show the manner in which the rankness of tropical vegetation is hurrying to destruction these interesting remains of an extinct race. "The tree is called the alamo or elm, the leaves of which, with those of the ramon, form in that country the principal fodder for horses. Springing up beside the front wall, its fibres crept into cracks and crevices, and became shoots and branches, which, as the trunk rose, in struggling to rise with it, unsettled and overturned the wall, and still grew, carrying up large stones fast locked in their embraces, which they now hold aloft in the air. At the same time, its roots have girded the foundation wall, and form the only support of what is left; and no sketch can convey a true idea of the ruthless gripe in which these gnarled and twisted roots encircle sculptured stones."—Vol. i. p. 394.

"So the orchideous plants, which are parasitical on trees, and are generally characteristic of the tropics, advance beyond the 45th degree, where they were found in New Zealand by Forster. In South America, also, arborescent grasses abound in the dense forests of the Chiloe Isles, in lat. 42° south, where, Darwin tells us, that 'they entwine the trees into one entangled mass, to the height of 30 or 40 feet above the ground. Palm trees, in the same quarter of the globe, grow in lat. 37°; an arborescent grass, very like a bamboo, in 40°; and another closely allied kind, of great length, but not erect, even as far south as 450°.'"*

In conclusion, is it necessary in urging the establishment of our geological museum on a firm basis and more extensive scale, to dilate on the advantages derivable from such an institution? The *cui bono*, which is so often addressed to cultivators of natural science by mere worshippers of mammon, is quite inapplicable here, for even in their eyes geological knowledge is valuable.

The geological character of a country bears a most important relation to the extent of its population,—to the means whereby that population is supported. If we think for a moment on the situation of our native city, and reflect that the means by which we carry on with advantage those manufactures which furnish employment to a teeming population, we may ask if it is likely that Glasgow would ever have reached its present extent and prosperity but for the valuable deposits of coal, ironstone, limestone, and sandstone, with which she is everywhere surrounded? This almost unlimited supply of coal and iron has enabled her to stretch a hundred arms to the most distant corners of the earth, and grasping the crude produce of the American shrub or Caribbean grass, the silk of India or the Australian fleece, she returns them to their native climes, variously and wonderfully fashioned to the use of man, by their passing visit to a coal field. The present may be truly said to be "the age of iron." Our country is becoming intersected by railroads in every direction,—a vast network of iron, along which the panting *locomotive* darts with the speed of the wind. Had the rocks of Clydesdale no connection with the development of genius in James Watt, no influence in calling forth the energies of Henry Bell? In our own day we have seen the dominions of Neptune invaded by Vulcan, and the "wooden walls of England" giving place to bulwarks of iron! The classic Mediterranean, the stormy Atlantic, and the Indian Ocean, are now traversed by Clyde-built steamers, propelled by Glasgow engines; whilst the towering Andes, and even the walls of the Celestial empire itself, reverberate with the sound of paddles and piston-rods, which were probably extracted from the "*black band*" of Monkland or Gartsherrie!

* Lyell's Principles, vol. i. page 170.

Catalogue of the Fossil Plants in the Glasgow Geological Museum, so far as these have been determined.

Asterophyllites foliosa, *Lindley and Hutton. Fossil Flora.*
〃 comosa, *L. & H.*
Calamites approximatus, *Sternb.*
〃 arenaceus, *Iæger.*
〃 Mougeottii, *Ad. Brong.*
〃 cannæformis, *Scloth.* This is evidently the base of a calamite stem; probably of one of the preceding species.
Cyclopteris orbicularis, *Ad. Br.*
Halonia regularis, *L. & H.*
Knorria taxina, *L. & H.*
Lepidodendron elegans, *L. & H.*
〃 gracile, *L. & H.*
〃 obovatum, *Sternb.*
〃 ornatissimum, *Ad. Br.*
〃 selaginoides, *Sternb.*
〃 Sternbergii, *Ad. Br.*
Lepidostrobus variabilis, *L. & H.*
Lyginodendron Landsburgii, *Gour.*
Neuropteris gigantea, *Sternb.*
〃 heterophylla, *Ad. Br.*
Pecopteris lonchitica, *Ad. Br.*
〃 chærophylloides, *Ad. Br.*
〃 laciniata (?) *L. & H.*
〃 adiantoides, *L. & H.*
〃 muricata, *Ad. Br.*
Sigillaria organum, *L. & H.*
〃 reniformis, *Ad. Br.*, and numerous undetermined species.
Sphenophyllum erosum, *L. & H.*
Sphenopteris (?) bifida, *L. & H. vel.*
〃 myriophyllum, *Ad. Br.*
Sternbergia approximata, *Ad. Br.*
Stigmaria ficoides, *Ad. Br.* In a late publication, Mons. Brongniart suggests the probability of *Stigmaria* being the branching roots of the *Sigillaria.*
Trigonocarpum olivæforme, *L. & H.*

Section of Lanarkshire Coal Field. BY WILLIAM MURRAY, Esq.

	Fa.	Ft.	In.
New Red Sandstone, various thickness,	0	0	0
Sandstone and Shale,	15	0	0
Upper Black Band Ironstone,	0	1	2
Sandstone and Shale,	24	0	0
UPPER COAL,	0	2	0
Sandstone and Shale,	8	0	0
ELL COAL,	0	3	0
Sandstone and Shale,	6	3	0
PYOT SHAW COAL,	0	4	6
Sandstone and Shale,	2	4	0
MAIN COAL,	0	4	0
Sandstone and Shale,	7	3	0
HUMPH COAL,	0	2	0
Sandstone and Shale,	4	3	0
SPLINT COAL,	0	4	0
Sandstone and Shale,	13	0	0
Muscle Band Ironstone,	0	0	8
Sandstone and Shale,	3	5	4
Black Band Ironstone,	0	1	4
Sandstone and Shale,	12	0	0
VIRTUE WELL COAL,	0	2	6
Sandstone and Shale,	20	0	0
KILTONGUE COAL,	0	3	0
Forward,	121	4	6

	Fa.	Ft.	In.
Brought up,	121	4	6
Sandstone and Shale,	6	0	0
DRUMGRAY COAL,	0	2	3
Sandstone and Shale, containing Ironstone Nodules,	35	0	0
Slaty-band Ironstone,	0	1	1
Sandstone and Shale,	20	0	0
Limestone,	0	4	0
Sandstone and Shale,	16	3	0
COAL 12,	0	2	2
Sandstone and Shale,	2	0	0
COAL 13,	0	2	6
Sandstone and Shale,	5	3	0
COAL 14,	0	2	6
Sandstone and Shale,	7	0	0
CANNEL COAL, 15,	0	1	2
UNDER COAL,	0	0	10
Sandstone and Shale, partly unknown,	25	0	0
Sandstone and Shale,	18	2	1
First Caumy Limestone,	0	1	6
Shale, Sandstone, thin Coal, and Limestone,	4	0	0
Kingshaw Second Limestone,	0	2	10
Forward,	264	3	5

	Fa.	Ft.	In.
Brought up,	264	3	5
Shale and Ironstone Nodules,	4	5	0
Second Caumy Limestone,	0	1	0
Shale,	1	4	6
FIRST RAES GILL Band Ironstone,	0	0	6
Shale,	0	3	6
TWO-BANDS IRONSTONE,	0	0	10
Shale,	0	1	9
IRONSTONE,	0	0	6
Shale,	0	2	1½
IRONSTONE,	0	0	3
Shale,	0	2	1½
IRONSTONE,	0	0	9
Shale,	0	3	10
IRONSTONE,	0	0	5
Shale,	0	4	8
IRONSTONE,	0	0	5
Hard Shale,	0	2	0
Forward,	275	1	7

	Fa.	Ft.	In.
Brought up,	275	1	7
IRONSTONE,	0	0	9
Sulphureous Shale,	0	4	11
IRONSTONE,	0	0	5
Shale and Ironstone balls,	0	8	0
IRONSTONE,	0	0	6
Shale with Shells,	0	4	0
Foul-band Limestone,	0	3	6
Shale and Sandstone,	18	0	0
Third Caumy Limestone,	0	2	6
Shale, Sandstone, and Ironstone balls,	3	0	0
Main Lime,	0	4	6
Shale, Sandstone, and Limestone,	26	0	0
Sandstone and Shale,	30	0	0
Fathoms,	357	0	8
Limestone of good quality, thickness not known.			
The Old Red Sandstone.			

Mr. John Alston made some observations on the noxious effects of smoke in the atmosphere.

Dr. Stenhouse stated that he had detected Thein in Paraguay tea, and that he had succeeded in obtaining this principle from tea and coffee by sublimation in Mohr's apparatus.

1st *March*, 1843,—*The* PRESIDENT *in the Chair.*

The following communication was read:—

XXXII.—*On the Vital Statistics of five large Towns of Scotland.* By ALEXANDER WATT, Esq., *City Statist, Glasgow.*

IT has long been matter of regret that the Registers of Marriages, Births, and Deaths, of Scotland, should have been allowed to remain in such a defective state, as to prevent the possibility of arriving at a correct knowledge of the Vital Statistics of the country;—and that, though in certain towns considerable attention has been paid to recording the deaths, no uniform plan has been adopted for the whole; —nor has any attempt been made, till lately, to arrange such facts as may be obtained from them, on an uniform systematic plan, so as to enable us to come to satisfactory conclusions, with regard to the comparative value of human life, in different localities;—or of the moral and physical causes, which operate in producing those various effects observable in the sanatory condition of different districts of town and country, in connection with atmospheric influence, which is found to exercise a powerful effect on the human frame.

I took an opportunity of bringing this subject under the consideration of the Statistical Section of the British Association, at their meeting in Glasgow (1840), in a paper which I read, giving a comparison of the Vital Statistics of Edinburgh and Glasgow. A committee of the Association was appointed, and funds voted for the further prosecution of this subject in Scotland. The magistrates and town council of Edinburgh having also placed funds at my disposal, to cover the expenses of collecting materials, to enable me to draw up a paper on the Vital Statistics of that city, for a series of years, I took upon myself the labour of accumulating the facts, and constructing Tables of Marriages and Deaths, for five of the principal towns of Scotland, together with Abstracts of the Births recorded, (incomplete as the Registers of Births are,) and of exhibiting some of the most important deductions to be drawn from them in the form of a report, which, with some curtailments that I regret were found necessary from want of space, is now published in the Transactions of the Association for 1842.

The principal results which I have deduced may be acceptable to the members of this society, more especially to those of the Statistical Section, who may have an opportunity of extending these researches, and of advancing our knowledge of the social condition of the people; and also of devising the best means of arresting, in its progress, that retrograde movement in the moral and physical condition of our town population, to which public attention has lately been so properly directed.

MARRIAGES.

From the facts which have been collected, (Report, pp. 135—141,) we find that there is a greater proportion of the male than of the female population married in all the towns, for which data have been obtained; yet, it seems, that in Edinburgh and Leith, there is 2·41 per cent. more females than males married. In Perth, there is 5·66 per cent. more females than males married. Still it appears, that in Edinburgh and Leith there is 0·287 per cent. more of the male than of the female population married; and in Perth, there is 0·113 per cent. more of the male than of the female population married. This arises from there being a much larger proportion of females than males residing in these towns. According to the census of 1841, there resided in Edinburgh and Leith 123·40 females for every 100 males, and in Perth by the same census, there were 115·59 females for every 100 males. In Glasgow and Dundee, however, there are more males than females married, both in the actual amount, and in the relative proportion they bear to the male and female population of these towns respectively. In Glasgow, while there is 0·167 per cent. more of the male than of the female population married, there is 0·887 per cent. more males than females married. And in Dundee, while there is 0·318 per cent. more of the male than of the female

TABLE I.—*Exhibiting amount of resident Marriages in five towns, and their proportions to the Population each year respectively.*

Years.	Edinburgh and Leith.			Glasgow.			Aberdeen.			Perth.			Dundee.		
	Population.	Marriages.	Proportion of Marriages to Population is as 1 to:—	Population.	Marriages.	Proportion of Marriages to Population is as 1 to:—	Population.	Marriages.	Proportion of Marriages to Population is as 1 to:—	Population.	Marriages.	Proportion of Marriages to Population is as 1 to:—	Population.	Marriages.	Proportion of Marriages to Population is as 1 to:—
			as 1 to ℔ cent.			as 1 to ℔ cent.			as 1 to ℔ cent.			as 1 to ℔ cent.			as 1 to ℔ cent.
1837	—	—	—	247,040	1927	128.20 or 0·78	61,985	460	134·75 or 0·74	22,489	142	158·37 or 0·63	54,467	506	107·64 or 0·92
1838	—	—	—	255,390	2193	116·45 or 0·85	62,672	456	137·43 or 0·72	22,409	145	154·54 or 0·64	56,156	535	104·96 or 0·95
1839	165,602	1276	129·78 or 0·77	264,010	2177	127·27 or 0·82	63,366	433	146·34 or 0·68	22,330	153	145·94 or 0·68	57,897	550	105·26 or 0·94
1840	166,089	1244	133·51 or 0·74	272,900	2294	118·96 or 0·84	64,068	435	147·28 or 0·67	22,251	127	175·20 or 0·57	59,691	478	124·87 or 0·80
1841	166,554	1281	130·01 or 0·76	282,134	2382	118·44 or 0·84	64,778	479	135·23 or 0·73	22,172	132	167·96 or 0·59	61,540	529	116·33 or 0·85
The average annual amount of Marriages, these years, to the mean Population, being as 1 to 131·088, or 0·762 ℔ cent.				The average annual Marriages, these years, to the mean Population, being as 1 to 120·290, or 0·831 ℔ cent.			The average annual Marriages, these years, to the mean Population, being as 1 to 140·004, or 0·714 ℔ cent.			The average amount of Marriages, these years, to the mean Population, being as 1 to 159·728, or 0·626 ℔ cent.			The average Marriages, these years, to the mean Population, being as 1 to 111·426, or 0·897 ℔ cent.		

TABLE II.—*Exhibiting amount of Burials, and Deaths exclusive of still-born children, for five towns, with their proportion to the population each year.*

Years.	Edinburgh and Leith.		Glasgow.		Aberdeen.		Perth.		Dundee.	
	Mortality.	Proportion of Mortality to Population being	Mortality.	Proportion of Mortality to Population being	Mortality.	Proportion of Mortality to Population being	Mortality.	Proportion of Mortality to Population being	Mortality.	Proportion of Mortality to Population being
		as 1 to per cent.		as 1 to per cent.		as 1 to per cent.		as 1 to per cent.		as 1 to per cent.
1837	Burials, 6242	26·29 or 3·80	Burials, 10886	22·69 or 4·40	Burials, 1469	42·19 or 2·36	Burials, 768	29·28 or 3·41	Burials, 1963	27·74 or 3·60
	Deaths, 5895	27·93 or 3·57	Deaths, 10270	24·05 or 4·15	Deaths, 1392	44·52 or 2·24	Deaths, 710	31·67 or 3·15	Deaths, 1811	30·07 or 3·32
1838	Burials, 5443	30·33 or 3·29	Burials, 7515	33·98 or 2·94	Burials, 1453	43·13 or 2·31	Burials, 682	32·85 or 3·04	Burials, 1511	37·16 or 2·69
	Deaths, 5038	32·77 or 3·05	Deaths, 6932	36·84 or 2·71	Deaths, 1411	44·41 or 2·25	Deaths, 635	35·28 or 2·83	Deaths, 1397	40·19 or 2·48
1839	Burials, 4385	37·76 or 2·64	Burials, 8130	32·47 or 3·07	Burials, 1213	52·23 or 1·91	Burials, 508	43·95 or 2·72	Burials, 1763	32·84 or 3·06
	Deaths, 4044	40·95 or 2·44	Deaths, 7525	35·08 or 2·85	Deaths, 1150	55·10 or 1·81	Deaths, 459	48·64 or 2·05	Deaths, 1647	35·15 or 2·84
1840	Burials, 4771	34·81 or 2·87	Burials, 9541	28·60 or 3·49	Burials, 1443	44·39 or 2·25	Burials, 538	41·35 or 2.41	Burials, 1434	41·62 or 2·40
	Deaths, 4398	37·76 or 2·64	Deaths, 8821	30·91 or 3·23	Deaths, 1385	46·25 or 2·16	Deaths, 483	46·06 or 2·17	Deaths, 1320	45·22 or 2·21
1841	Burials, 4495	37·05 or 2·69	Burials, 9605	29·37 or 3·40	Burials, 1103	58·72 or 1·70	Burials, 533	41·59 or 2·40	Burials, 1469	41·89 or 2·38
	Deaths, 4142	40·21 or 2·48	Deaths, 8886	31·75 or 3·14	Deaths, 1034	62·64 or 1.59	Deaths, 494	44·88 or 2·22	Deaths, 1358	45.31 or 2·20

As circumstances prevented me from obtaining returns of the amount of proclamations of Marriages for 1837 and 1838, for Edinburgh and Leith, the columns for these years, in Table I., are not filled up.

population married, there is no less than 2·96 per cent. more males than females married. There being 110·41 females for every 100 males residing in Glasgow, and 117·37 females to every 100 males in Dundee, by the census of 1841. In Aberdeen, there is 0·352 per cent. more of the male than of the female population married, while the amount of females married is 0·30 per cent. greater than that of the males; there being 128·59 females in Aberdeen to every 100 males, by the census of 1841.

These results are all brought out on the average of those years stated in the foregoing Table, No. I. In comparing the proportions in this Table, it may be as well to keep in view, that the proportion of marriages for the whole of England and Wales, amounts to 0·785 per cent. of the population.*

BIRTHS.

As the registers of births in Scotland are so very defective as to be of no use in enabling us to arrive at a knowledge of the Vital Statistics, either of town or country,† it seems unnecessary here to give any abstract of the returns obtained from them, farther than to state, that the mean annual proportion of births recorded in the Registers of births for Edinburgh and Leith is 0·992 per cent. of the population; for Glasgow 1·160 per cent.; for Aberdeen 1·311 per cent.; for Perth 1·704 per cent.; and for Dundee 1·497 per cent.; while it appears from the Fourth Annual Report of the Registrar General, the mean annual proportion of births for England and Wales is 3·174 per cent.

DEATHS.

As it is of the greatest importance that the returns from the Registers of deaths should be constructed on an uniform plan, the results obtained for the different towns in Scotland are based on the same principles as those for the Mortality Bills of Glasgow, which I have drawn up for the Lord Provost, Magistrates, and Council of that city. The classification of the diseases in the tables, *the arrangement*

* See Fourth Annual Report of the Registrar General.

† The only register of births, deaths, and marriages in the country parishes of Scotland, is that kept by the Session Clerk of the Established Church, in which few of the Dissenters register. The following abstract, supplied by the Rev. Dr. James Thomson, exhibits the number of births registered for five years, in the parish of Eccles, Berwickshire, possessing a population of 1930, and 480 church communicants, and where several families of dissenters reside, and shows that few of the latter register:—

	DISSENTERS.	CHURCHMEN.
1838,	1	16
1839,	4	21
1840,	1	26
1841,	2	28
1842,	5	24
Mean for 5 years,	2·6	23

of which is given in the appendix of these Bills, and in the Report in the volume of the Association, is far from being so perfect as would be attainable were the Registers of deaths in Scotland kept in a more perfect and systematic plan, yet it is believed, that the arrangement is about as complete as can be satisfactorily followed in the present state of these Registers; and as the Registers of the towns reported on are kept in a manner similar to each other, comparisons of the causes of death at different ages, more especially of the more easily discriminated diseases, such as croup, fever, hooping-cough, measles, scarlet fever, and small-pox, may be considered as satisfactory. One of the greatest advantages of the Registers in these towns of Scotland is, that the ages at which deaths take place are carefully recorded, which it will be found is of great importance in arriving at a knowledge of the comparative sanatory condition of towns.

It is to be observed, that in the Mortality Tables for our Scotch towns, there is a distinction between the amount of burials and the amount of deaths; this becomes necessary to enable the reader to make comparisons between the amount of mortality in the English towns and that of the Scotch, as the still-born children are not given in the Reports of the Registrar General.

As the population for the different towns, with the exception of Edinburgh and Leith, are stated for each year in the foregoing Table of Marriages, they are not inserted in Table No. II. The population of Edinburgh and Leith amounts in 1837, to 164,676; in 1838, to 155,113; in 1839, to 165,602; in 1840, to 166,089; and in 1841, to 166,554.

From the returns it appears (Report, p. 180,) that in Edinburgh, exclusive of Leith, although on an average of years the number of female deaths is greater than the number of male deaths by 3·194 per cent., owing to there being a much greater proportion of females than males in that city, the female life is better than the male life by 0·500 per cent.; while (page 182,) in Glasgow, though the number of male deaths is 5·30 per cent. greater than the number of female deaths, the female life is only 0·462 per cent. better than the male life. In Aberdeen, the female life is better than the male life by 0·483 per cent., and the number of female deaths is greater than the number of male deaths by 0·819 per cent. In Perth, the female life is better than the male life, by 0·207 per cent., and the number of female deaths is 6·104 per cent. greater than the number of male deaths. And in Dundee, the female life is 0·332 per cent. better than the male life, though the number of female deaths is 2·551 per cent. greater than the number of male deaths.

The following Table exhibits the average annual deaths, for three years, in Edinburgh and Dundee, and for five years, in Glasgow, Aberdeen, and Perth, with the proportion to the total average annual deaths of each of a series of diseases.

TABLE III.

DISEASES.	Edinburgh. Mean Popula. 137,986, for 1839-40-41.		Glasgow. Mean Popula. 264,010, for 1837-38-39-40-41.		Aberdeen. Mean Popula. 63,366, for 1837-38-39-40-41.		Perth. Mean Popul. 19,435, for 1837-38-39-40-41.		Dundee Mean Popula. 69,691, for 1839-40-41.	
	Average annual deaths for three years.	Proportion to the total average annual deaths for three years.	Average annual deaths for five years.	Proportion to the total average annual deaths for five years.	Average annual deaths for five years.	Proportion to the total average annual deaths for five years.	Average annual deaths for five years.	Proportion to the total average annual deaths for five years.	Average annual deaths for three years.	Proportion to the total average annual deaths for three years.
		1 to every		1 to every		1 to every		1 to every		1 to every
Accidents, ...	82	42·92	189⅖	44·80	14⅖	29·98	13	39·47	34	42·42
Aged, ...	433⅓	8·12	744⅘	11·39	80⅘	5·33	105⅖	4·86	132⅓	10·89
Asthma, ...	62⅔	56·17	203⅗	41·68	13⅗	31·72	23⅘	21·56	50	28·83
Bowel Complts.,	231⅓	15·21	977⅘	8·68	22⅘	18·92	33⅖	15·36	157	9·18
Catarrh, ...	12	293·33	98⅕	86·42	6⅖	67·40	13⅖	38·29	16⅓	88·26
Childbirth, ...	27⅓	128·78	84⅕	100·79	3⅖	126·88	3	171·06	11⅓	127·20
Croup, ...	49⅓	71·35	165⅕	51·37	3	143·80	11⅕	45·82	22	65·53
Decline, ...	602⅓	5·84	1383⅖	6·13	51⅘	8·32	63⅘	8·04	179	8·05
Dropsy, ...	128	27·00	263⅖	32·22	14⅕	30·38	17⅘	28·83	61⅓	23·50
Fever, ...	325	10·83	1176⅕	7·21	61⅖	7·02	38⅕	13·43	121⅓	11·88
Head, of, ...	302⅔	11·63	456⅗	18·58	27⅘	15·51	41⅖	12·39	89	16·19
Heart, of, ...	51	69·02	53	160·13	2⅕	196·10	4⅘	106·91	13⅓	108·12
Hoopingcough, ..	118	29·83	436⅗	19·44	7⅗	56·76	18⅕	28·19	74	19·48
Inflammation, ...	271⅓	12·97	489⅗	17·33	30⅖	14·19	27⅕	18·86	85⅔	16·82
Measles, ...	104	33·84	523⅘	16·20	10⅕	42·29	18	28·51	106	13·60
Nervous, ...	21⅔	162·46	55⅕	153·74	17	25·37	22⅕	23·11	23	62·68
Scarlet Fever, ...	72⅓	48·66	254⅘	33·31	13⅖	32·19	13⅗	37·73	72	20·02
Small Pox, ...	77⅓	45·51	381⅕	22·26	11	39·21	9⅘	52·36	83⅔	17·23
Miscellaneous, ...	215	16·37	283⅗	29·92	40	10·78	22⅕	23·11	72	20·02
Total Ascertd.,	3186⅔	1·10	8220⅗	1·03	431⅖	1·00	500⅖	1·02	1403⅓	1·02
Total Not Do.	333⅓	10·56	266⅕	31·88	842⅘		12⅘	40·09	38⅓	37·60
Total Deaths, ...	3520	1·00	8486⅘	1·00	1274⅕		513⅕	1·00	1441⅔	1.00

The proportions which the Diseases, stated in the above Table, bear to the whole amount of Deaths, and also to the Populations of each of the towns respectively, are given in the Tables contained in the Report already referred to; and, what is of still greater importance, the ages at which death takes place by the various diseases are carefully exhibited.

It had occurred to me, on drawing up papers on the Vital Statistics of Glasgow and of Edinburgh, that the uniformity of certain results was deserving of particular notice, and led me to the belief, that by a more extended field of observation, it would be found that this uniformity was not accidental, but the result of certain specific laws of mortality operating at different ages. It will be perceived that this view of the case is very much strengthened by facts brought forward in the Report on the Vital Statistics of five large towns of Scotland;

and they are still further confirmed by the results exhibited in the Mortality Bill of this city for 1842.

The most striking uniformity in the amount of deaths, caused by any of the diseases at certain ages, is in the cases of fever in Edinburgh and Glasgow. It will be found that in Edinburgh the average annual amount of fatal cases of fever, for the *three* years ending with 1841, is 325, or 0·235 per cent. of the mean population these years; and, in Glasgow, the average annual amount of fatal cases of fever, for the *five* years ending with 1841, is 1156⅕, or 0·445 per cent. of the mean population of these years. Notwithstanding the difference in the amount of deaths by fever, in these two cities, it is found that the amount of deaths which occur by that disease, under five, under twenty, and at twenty years of age, and upwards, bear an uniform proportion to the whole fatal cases of fever in these two towns respectively. The following figures show that the difference is very small indeed:—

	In Edinburgh. Per cent.	In Glasgow. Per cent.
Proportion of deaths, under 5 years, caused by fever, to the whole deaths by that disease,	12·41	12·07
Do. do.—under 20 years, . .	29·74	29·05
Do. do.—20 years and upwards, .	70·25	70·94

I have deduced similar results for eruptive and other diseases, for these towns, although some of them are not so very close to each other as the foregoing, arising from causes yet to be ascertained, yet it will be found that they are very nearly the same. Nor are these results confined to the operation of these diseases in the Scotch towns, as is obvious from the following abstract:—

	In Manchester. Per cent.	In Liverpool. Per cent.
Proportion of deaths, under 5 years, caused by measles, to the whole deaths by that disease,*	92·49	91·27
Do. do.—under 20 years, . .	99·35	99·75
Do. do.—20 years and upwards, .	0·64	0·24

While there is such a great similarity in the proportions in the amount of deaths by measles, at the several ages, in these towns, it will be observed that the proportion of the whole of these cases to the population in Manchester is 0·275 per cent., and only 0·146 per cent. in Liverpool, for the year for which the example is given.

That there are specific laws which govern the amount of deaths, by the various diseases, is very strongly confirmed by the proportions exhibited in the Glasgow Mortality Bill for 1842, (not yet published,)

* For the year 1839.

corresponding with those formerly brought forward, for an average of years. We may take small-pox, as an example:—

	In Edinburgh, During an average of years. Per cent.	In Glasgow, During 1842. Per cent.
Proportion of deaths, under 5 years of age, caused by small-pox, to the whole deaths by that disease,	82·68	82·33
Do. do.—under 20 years, . .	95·23	96·70
Do. do.—20 years and upwards, .	4·76	3·29

So far as has yet been proved, the results for a series of former years, for Glasgow, and those for 1842 are also very nearly the same, more especially in the case of measles.

It is not the least remarkable of the results exhibited in relation to the Vital Statistics of Scotch towns, that the proportions of deaths at various ages, caused by the diseases classed under the head of bowel complaint, are nearly the same, more especially in Edinburgh and Perth, notwithstanding the inaccuracies which may be expected to arise from the present mode of registering these complaints.

The following is the annual average proportion which the deaths by bowel complaint, at different ages, bear to the whole annual average deaths by that complaint, in different towns, and also to the population.

AGES.	Edinburgh.		Perth.		Dundee.		Glasgow.	
	Proportion to whole Deaths.	Proportion to the Population.	Proportion to whole Deaths.	Proportion to the Population.	Proportion to whole Deaths.	Proportion to the Population.	Proportion to whole Deaths.	Proportion to the Population.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Under 2 years of age,	79·106	0·132	79·041	0·135	77·919	0·204	84·066	0·311
Under 5 years, ...	85·014	0·142	82·634	0·142	84·288	0·221	90·693	0·335
Under 20 years, ...	87·608	0·146	85·029	0·146	86·836	0·228	93·475	0·346
20 years and upwards,	12·391	0·020	14·970	0·025	13·163	0·034	6·524	0·023

It will be observed, from the above Table, that the proportions for Glasgow and Dundee are not quite so close to each other as those for Edinburgh and Perth. In the prosecution of this subject, as I have observed elsewhere, it may be found that these differences arise from the peculiar habits or condition of the people, together with the local circumstances of towns. In the meantime, however, a considerable portion of the differences in these results may safely be attributed to inaccuracies in the registration of the disease.

I am the more particular in directing attention to the operation of these laws, which appear to govern the amount of mortality at different ages by the several diseases, as they have hitherto escaped observation; and the examples thus brought forward seem to warrant the belief, that under more advantageous circumstances, in respect to the better registration of the causes of death, the precise effects of these laws may be so clearly established, as to place the science of vital statistics upon a more certain basis, and lead to the adoption of such sanatory regulations as to secure—what may be esteemed one of the greatest blessings to a community—a healthy population.

I would farther observe, that many of the results brought forward in the tables, and in the general remarks upon them, now published in the volume of the British Association, tend to prove that the excess of mortality in various localities, is as the condition of the people and the local circumstances of towns. This is exemplified to a considerable extent by a comparison of the mortality at different ages in London and Manchester, with that of Edinburgh and Glasgow at the same ages. It cannot escape observation, that with the exception of the difference in the amount of their populations, London and Edinburgh bear a great resemblance to each other, as to the general condition and occupations of their inhabitants; and it is well known, that Manchester and Glasgow bear a close resemblance to each other in these respects. The figures in the three tables given in the original report exhibiting the comparative mortality of five English towns, prove that the mortality of Manchester at different ages, bears the same proportion to that of London, as the mortality of Glasgow at the same ages bears to that of Edinburgh. Though the three tables for the English towns, substituted for those in the original report, for the very proper reasons stated by the chairman in his introduction to the report, do not give the figures which exhibit this fact in the most striking light, they may be obtained from them; and although these figures do not turn out to be precisely the same as those contained in the original tables, they are not very different.

The facts recorded, (Report, Table No. 74, page 185,) show that the mortality under five years of age in Glasgow, is greater than it is in Edinburgh under the same age by 10·96 per cent.,* while (No. 75, page 186,) it is found, that the mortality in Manchester under five years of age is 10·83 per cent. greater than it is in London under the same age. Again, (Table 76,) it will be seen that in Glasgow the mortality under 20 years of age is 12·07 per cent. greater than in Edinburgh under that age; and (Table 77,) it will be found that the mortality in Manchester under 20 years of age is 11·76 per cent. greater than in London under the same age. It will also be observed, (Table 78,) that in Glasgow the mortality at 20 years and upwards, is 12·07 per cent. less than it is in Edinburgh; while (Table 79,) it will be found that the mortality at 20 years and upwards in Manchester is 11.76 per cent. less than it is in London.

* It will be observed, that these per centages are of the whole deaths in each town respectively.

As it is only the amount of parties buried, and not the amount of parties who die within the limits of these towns, that we obtain from our present Registers, we can therefore only come to a knowledge of the comparative sanatory conditions of these towns by attending to the ages at which death takes place.

The important results obtained from a comparison of the mortality of these towns, are well worthy of consideration, and in connection with the other facts brought forward, strongly prove that it is more from the prevention of disease than from the curing of it, that we are to expect the greatest advantage to the well-being of our town population. And it is to our municipal authorities, as well as to the legislature, that we are to look for carrying out such sanatory improvements as may promote the health, and consequently, the general happiness of the people.

Professor Gordon made some observations on the causes of accidents in coal mines, and on the proper means of ventilating the latter.

A committee, consisting of Professor Andrew Buchanan, Mr. Watt, and R. D. Thomson, M.D., were appointed to report on the means of improving the state of Vital Statistics in Scotland, and the condition of the people in reference to disease.

15*th March*, 1843,—*The* Vice-President *in the Chair.*

Messrs. William Keddie, John M'Andrew, and Andrew J. Duncan, were admitted as members.

Mr. James Thomson, C.E., made a communication on the atmospherical railway.

The following paper was read:—

XXXIII.—*Examination of the Cowdie Pine Resin.* By Robert D. Thomson, M.D.

The Cowdie Resin has been known for some years to those botanists who are familiar with the vegetation of New Zealand. Mr. Robert Brown informs me that he possesses a very large and elegant specimen of this substance; but it does not appear to have hitherto attracted the attention of chemists. I have been acquainted with its external properties for some years, from a specimen in our private chemical museum in the college, but it was only in the course of last spring that my attention was particularly called to its examination, in consequence of having large and beautiful specimens presented to me, by my friend, Dr. Ernst Dieffenbach, formerly of Giessen, and lately naturalist to the New Zealand Company, who, by his laborious and indefatigable exertions, while resident in New Zealand, has contributed so extensively to our knowledge of the moral and physical condition of that interesting British colony.—(*See Dieffenbach's Travels in New Zealand, London, 8vo, 2 vols.*)

I am indebted to Mr. Robert Brown for the information that this resin is derived from the *Dammara Australis*—a tree which belongs to the natural order *Coniferæ* and division *Abietinæ.*—(*See also Lambert's Pines.*) The resin is, I believe, known by the native name of "*Cowdie*," and, in consequence, the tree from which it exudes is usually termed the "Cowdie Pine." There is an excellent specimen of this tree in the Glasgow Botanic Garden, on which I have been able to detect distinct traces of a resinous exudation. In the same garden, also, there is a specimen of the *Dammara orientalis*, from which the dammara resin, previously described by chemical writers, is probably derived; (*Lecanu and Brandes. Thomson's Veget. Chem., p.* 538;) and on the stem of this species, also, I have observed unequivocal proofs of the presence of a resin. The cowdie resin occurs in large masses, from the size of the fist to a much greater magnitude. It is transparent when freshly fractured; but, as it comes from New Zealand, generally it is slightly opalescent—a character which is said to be produced by the action of water or moisture. The colour of the resin is light amber. It is easily fused, and then emits a resinous or turpentine odour. A small portion of the resin dissolves in weak alcohol, but the greater part remains insoluble. The solution in alcohol evolves the smell of turpentine. The resin, when agitated with hot absolute alcohol, forms a fine varnish, which might be found valuable in the arts. A similar result follows its treatment with oil of turpentine. Sulphuric acid dissolves it; and water, added to the solution, precipitates the resin in flocks.

Resins are usually divided into two classes, and are termed, according to their characters, *acid* and *neutral* resins. The cowdie resin appears to belong to both of these classes. When boiled with spirits, a portion of the resin dissolves, and there remains a white resin, which is insoluble in weaker spirits, but which forms, with absolute alcohol, a fine transparent varnish. That portion of the resin which dissolves in weak alcohol, possesses all the characters of an acid, forming salts with metallic oxides, and is not precipitated by ammonia; while the precipitate, occasioned by adding water to the alcoholic solution, is quite soluble in ammonia. The alcoholic solution of the acid portion of the resin reddens vegetable blues. I propose to term it *Dammaric* acid; while the residual white resin may be called *Dammaran*, to distinguish it from the Dammarin of Lecanu and Brandes.

ENTIRE RESIN.

The entire resin, without the action of any chemical reagent, was pulverized and dried at 212° F., and afforded, in two analyses, the following results, when burned with oxide of copper:—

I. 9·435 grs. gave 25·71 grs. CO_2, and 8·73 grs. HO.
II. 5·69 do. 15·565 grs. CO_2.

Hence we have—

	I.	II.	Mean.
Carbon, ...	74·30	74·60	74·45
Hydrogen, ...	10·28		10·28
Oxygen, ...	15·42		15·27
	100·00		100·00

To determine whether the resin was sufficiently dried, a portion was fused and exposed to a temperature of 350° for some time. The following were the results of two analyses:—

I. 6·97 grs. gave 19·30 grs. CO_2, and 6·18 grs. HO.
II. 7·96 do. 6·93 grs. HO.

This is equivalent to—

	I.	II.	Mean.
Carbon, ...	75·46		75·46
Hydrogen, ...	9·85	9·67	9·76
Oxygen, ...	14·69		14·78
	100·00		100·00

From these data we may deduce the following composition:—I use ·75 for carbon;—that being the number employed by Dr. Thomson since 1813, as deduced by him from the specific gravity of carbonic acid and composition of olefiant gas. The number of Professor Liebig (·758,) is so near this that the formula will scarcely be altered by the use of the latter number.

			Calculation.	Experiment.
Carbon, . . .	·75 × 40 =	30·	= 75·23	75·46
Hydrogen, . .	·125 × 31 =	3·875	= 9·73	9·76
Oxygen, . . .	1· × 6 =	6·	= 15·04	14·78
		39·875	100·00	100·00

The close correspondence of the theoretical and practical results in reference to the hydrogen, may lead us with some degree of confidence to assume the following formula, as representing the composition of the Cowdie Resin

$$C_{40} \quad H_{31} \quad O_6$$

and adopting an analogous view to that of Professor Liebig, in reference to the composition of turpentine resins, we may consider the basis of the resin

$$C_{40} \quad H_{30} \quad \begin{matrix} H \\ H \end{matrix}$$

becoming by the substitution of one atom of oxygen, and the addition of 5 atoms of oxygen,

$$C_{40} \quad H_{30} \quad \begin{matrix} H \\ O \end{matrix} + O_5$$

HYDROUS DAMMARIC ACID.

The resin was boiled in successive portions of alcohol, until the latter ceased to dissolve any more of it. The solution was then precipitated by water. The precipitated resin was washed and dried at the temperature of 212° F. (100° C.) but not fused.

6·9 grs. gave when burned with oxide of copper

18·39 grs. CO_2 and 5·78 grs. HO.

The result is therefore for the hydrous acid :—

	Experiment.	Calculated.	
Carbon, . . .	72·69	73·39	40 atoms.
Hydrogen, . .	9·31	9·47	31
Oxygen, . . .	18·00	17·14	7
	100·00	100·00	

This approaches the formula C_{40} H_{31} O_7.

If the alcoholic solution of the *dammaric acid* be allowed to evaporate spontaneously, the resin is deposited apparently in the form of crystalline grains.

ANHYDROUS DAMMARIC ACID.

To determine the atomic weight, a solution of dammaric acid in alcohol was mixed with an alcoholic solution of nitrate of silver, to which some caustic ammonia had been added, at the boiling temperature; the silver salt after being washed and dried was analysed ;—

4·26 grs. gave by ignition ·58 Silver = ·622 Oxide of Silver.

From which we have—

Oxide of Silver, ...	14·60	14·75	1 atom.
Dammaric Acid, . . .	85·40	86·27	2 atoms.

To determine the composition of the anhydrous acid, the silver sal was analysed.

6·62 grs. gave when burned with oxide of copper, 15·73 CO_2 and 5·39 HO.

The composition of the silver salt is, therefore,

Carbon, . . .	64.78	65·45	Atomic weight = 86·27 or 43·13 × 2
Hydrogen, . .	9·01	9·11	
Oxygen, . . .	11·61	11·72	
Oxide of silver,	14·60	14·75	
	100·00	101·02	

and that of the anhydrous acid is,

	Experiment.			Calculation.
Carbon, . .	75.85	= 43 × ·75	= 32·25	75.43
Hydrogen, .	10·56	= 36 × ·125	= 4·5	10·52
Oxygen, . .	13·59	= 6 × 6·	= 6	14·05
	100·00		42·75	100·00

Hence the formula of the anhydrous acid corresponds with

$$C_{43} \quad H_{36} \quad O_6$$

and the silver salt is,

Bidammarate of silver $2\,(C_{43}\,H_{36}\,O_6) + A_g\,O$

Or if we view the analysis as giving an excess of hydrogen, the composition of the anhydrous acid would be as follows:

40	×	·75	=	30·		75·47
30	×	·125	=	3·75		9·44
6	×	6·	=	6·		15·09
				39.75		100·00

The formulae would then be

Hydrous Acid, ...	C_{40}	H_{31}	O_7
Anhydrous Acid, . . .	C_{40}	H_{30}	O_6
		H	O=HO

the difference being an atom of water.

DAMMARAN.

I give this name to the substance remaining after the separation of the dammaric acid. It is a fine white brittle resin, apparently insoluble in weaker spirit, but forming with absolute alcohol a beautiful colourless varnish, and also, a similar preparation with oil of turpentine. This substance appears to be identical in composition with the resin. When dried at 212°, (100 C.) its composition was found to be as follows:—

7·4 grs. gave when burned with oxide of copper, CO_2 20·36, HO 6·4.

This is equivalent to,

Carbon, ...	75·02
Hydrogen, ...	9·60
Oxygen, ...	15·38*
	100·00

If we compare this with the formula, $C_{40}\,H_{31}\,O_6$, we shall find that it corresponds very closely.

By exposing this substance to a higher and longer continued heat, it was found to absorb oxygen pretty rapidly, and to alter, of course, in its composition, as appears by the two following analyses:—

I. 6·57 grs. gave 16·75 CO_2 and 5·7 HO.

II. 7·64 grs. gave 20·33 CO_2 and 6·7 HO.

	Dried at 300° for 3 days.	Dried at 350° for 4 days.
Carbon, . . .	72·56	69·25
Hydrogen, . .	9·74	10·32
Oxygen, . . .	17·70	20·43
	100·00	100·00

* By Mr. David Miller, Laboratory Assistant.

The influence of heat may hence account in some degree for the more rapid formation of resins from oils of the turpentine type in warm countries, and also for the greater solidity which resins acquire than in more temperate latitudes.

DAMMAROL.

When the Cowdie resin is exposed to the heat of a spirit-lamp, it melts, and, by the continuation of not too high a temperature, heavy vapours arise which gradually and slowly pass over, and condense in the receiver in the form of a fine amber-coloured oil swimming on the surface of water. It is obvious, therefore, that by this treatment the resin has been resolved into *dammarol* and water. By evaporation at 300°, the water disappears and the oil remains. It boils at a high temperature. 5·98 grs. gave when burned with oxide of copper, 18·03 grs. CO_2 and 6.02 HO.

The composition of *dammarol* is, therefore,—

Carbon,	82·22
Hydrogen,	11·14
Oxygen,	6·64
	100·00

The following would be the composition if the formula were $C_{40} H_{28} O_3$, supposing that three atoms of water were detached from the resin to form *dammarol*.

Carbon,	82·19	40
Hydrogen,	9·56	28
Oxygen,	8·25	3
	100·00	

The analysis gives an excess of hydrogen, proceeding from the retention of water.

The action of heat upon resins was known as early as 1688, (*Memoires de' L'Academie Royale des Sciences de Paris*, 1688,*) and the relative proportions of water and oil obtained by the distillation of these bodies were accurately noted. Colophan or common rosin, for example, it is stated when distilled in the quantity of two pounds, afforded 26 ounces 4 drs. of oil, and 3 ounces 1 dr. of an acid liquor. Neumann, a most sagacious chemical writer, whose works may even yet be consulted with benefit by modern chemists, was well aware of the nature of the products of the distillation of resins, and of the derivation of resins from essential oils. "Essential oils," he says, "by digestion or heat, (*Neumann's Chemistry, by Lewis*, 4*to*, 1758, p. 269,) change into balsams, and at length into brittle resins. Distilled again in this state, they yield like most of the natural resins, a portion of fluid oil."

* See also *Collection de pièces Academiques*, Tome I. p. 141.—1754.

DAMMARONE.

When dammara resin is finely pounded and mixed intimately with five or six times its weight of quick-lime, and the united powders are distilled by the low heat of a spirit-lamp, either in a tube retort, or in a larger vessel, if the quantity experimented on is more considerable, dense white fumes speedily make their appearance, which condense in the receiver first in the form of water, having an ethereal odor, and gradually as a thick amber coloured oil which floats on the surface of the water. By the application of a heat of 300°, the water soon disappears, while a dark oil remains, which may be further purified by rectification. This oil is exceedingly liquid when hot, but on cooling and exposure to the air, it becomes thicker. Its boiling point is above 270° F. It burns with a dense smoke, and is soluble in alcohol.

4·3 grs. gave when burned with oxide of copper, 13·59 CO_2 and 4·465 grs. HO.

This is equivalent to,

Carbon, ...	86·22
Hydrogen, ...	11.53
Oxygen, ...	2·25
	100·

The result corresponds with the following calculation :—

Carbon, . . .	38 × ·75	= 28·5	85·39
Hydrogen, . .	31 × ·125	= 3·875	11·61
Oxygen, . . .	1 × 1·	= 1·	3·00
		33·375	100·00

There is an excess of carbon in the analysis, which I believe to be owing to the very great difficulty of separating the whole of the carbo-hydrogen oil which forms the basis of the resin, and is disengaged in the first stage of the distillation. All those who have made researches on resins, are familiar with this obstacle to precise formulæ. If we compare this formula with that of dammaran, the action is pretty obvious.

Dammaran, .	C_{40}	H_{31}	O_6
Dammarone, .	C_{38}	H_{31}	O
	C_2		$O_5 = 2\,CO_2 + O$

By this it appears that two atoms of carbonic acid have been removed, and one atom of oxygen; that carbonic acid is fixed by the lime, is proved by the effervescence of the residue in the retort on the addition of an acid. The cause of the disappearance of the oxygen is not so clear; and I therefore prefer the following formula, where the removal of the oxygen is accounted for :—

Carbon, ...	38 × ·75	=	28·5	85·64
Hydrogen, . . .	30 × ·125	=	3·75	11·27
Oxygen, ...	1 × ·1	=	1·	3·09
			33·25	100·00

The comparative formula will then be—

$$\begin{array}{ccc} C_{40} & H_{31} & O_{6} \\ C_{38} & H_{30} & O \\ \hline 2 & 1 & 5 \end{array} = 2\,CO_2 + HO$$

The preceding experiments assist in carrying out certain generalisations which had been deduced from a more limited series of data, and serve to confirm the idea of the analogy of the resins, and of their derivation from an oil of the turpentine type.

The resins, perhaps, are more interesting to the chemist than at first appears, from their analogy to other bodies of vegetable and animal origin. Whether their basic oils are derived from the deoxidation of other bodies in plants supplied with a larger amount of oxygen, or are formed directly from their gaseous constituents, is subject for inquiry. If it be true that plants evolve no heat, (although it is not easy to comprehend how gases can be condensed without such a disengagement,) then it would appear that no combination of carbon and oxygen—no proper combustion, such as occurs in the animal system, takes place in plants; and hence it would follow that the essential oils are formed directly from their elementary constituents. But the statement (Brongniart,) which has been made, that plants evolve heat in fertilization, that oxygen is absorbed, and carbonic acid given out, would appear to favour the idea that combustion can occur in plants as well as in animals. The admission of the operation of this process in plants would throw much light on the following table, representing a descending series, with the exception of the first, into which some bodies of animal origin are introduced for the same of comparison:—

Protein, ...	C_{48}	H_{36}	O_{14}	N_{6}
Gum, ...	C_{48}	H_{44}	O_{44}	
Starch, ...	C_{48}	H_{40}	O_{40}	
Base of Cane Sugar, . .	C_{48}	H_{36}	O_{36}	
Fat, ...	C_{44}	H_{40}	O_{4}	
Bees-Wax, ...	C_{40}	H_{40}	O_{2}	
Dammaran, ...	C_{40}	H_{31}	O_{6}	
Cholesterin, ...	C_{38}	H_{32}	O	
Base of the Resins, . . .	C_{40}	H_{32}		

In reference to the preceding table, the analogies of starch and gum are sufficiently apparent in the analysis of flour, while the conversion of starch into sugar, by artificial methods, and in vegetation, is too well known to require more than a notice. The production of wax from sugar was long ago shown by Huber, and has recently been happily brought forward by Liebig, in evidence of the purposes which sugar and starch fulfil in the respiratory economy. The intermediate position which fat sustains between sugar and wax, renders the views of Liebig, with respect to the production of fat from starch, highly probable; and I am strongly inclined to infer that cholesterin occupies a lower stage in the reducing process, from the fact of my having obtained from it different products, and one approaching naphtha in its odour and apparent composition, and from various other considerations, which I hope soon to be able to detail more fully. The possibility of the derivation of turpentine oils and resins from starch and sugar scarcely requires to be pointed out.

Note.—Since writing the above, the observation by the French chemists of the existence of stearic acid in wax, confirms the plausibility of Liebig's view of the analogy of fat and wax, and strengthens the opinion which I have long entertained, that cholesterin is the wax of mammiferous animals.

29th March, 1843,—*The* Vice-President *in the Chair.*

The report on the present state of Vital Statistics in Scotland was read, and referred to a committee.

XXXIV.—*On the Fibrin contained in the Animal Fluids, the Mode in which it coagulates, and the Transformations which it undergoes. By* Andrew Buchanan, M.D., *Professor of the Institutes of Medicine, University of Glasgow.*

I.—CHARACTERS OF THE FIBRIN IN THE ANIMAL FLUIDS.

The substances named Fibrin by physiologists do not seem to be all identical in chemical composition. The buffy coat of the blood has been recently ascertained to comport itself quite differently with chemical reagents, from the substance which forms the basis of muscular fibre. The same is probably true of all the substances to be here spoken of, as they are more analogous to the former than to the latter modification of Fibrin. Still farther, they probably vary in chemical composition in the successive changes of condition which they are observed to undergo.

The substances, to which I wish here to direct your attention, are distinguished by the following characters. They all form part of certain animal fluids, of the serous or albuminous class, from which, when withdrawn from the body, they separate spontaneously, concreting into a soft tremulous mass. The circumstance of their existing in the liquid form distinguishes them from the solid fibrin of the muscles; while their spontaneous coagulability distinguishes them from albumen, which they closely resemble in all other respects, and which is the chief animal principle found in the liquids in which they occur.

II.—ANIMAL FLUIDS CONTAINING FIBRIN.

The principal animal fluids, which contain fibrin, are the Blood; the Lymph of the lymphatic vessels; the Liquid of Blisters; the Coagulable Lymph, as it is usually called, met with under circumstances to be mentioned hereafter; and lastly, the liquid of the properties of which I had the honour to read to the Society an account in the year 1836, formed by the mixture of the serum of the blood with serum from cavities lined by serous membranes.

III.—OBJECTS OF THIS MEMOIR.

1. The fibrin, existing in these liquids, is usually held to exist in them in a state of solution; only passing to the solid state after they are withdrawn from the body, during coagulation. I believe that opinion to be erroneous: and the first object of this paper is to show, that the fibrin does not exist in those liquids in the state of solution, but exists while yet within the body, already solidified, and organized in the form of granules and vesicles; and that the process of coagulation consists, simply, in the aggregation of these minute granules and vesicles into a mass visible by the naked eye. This can only be demonstrated by observing the coagulable liquids, under the microscope, before, during, and after coagulation.

2. The second object of this paper is to show, that the fibrinous granules and vesicles contained in these coagulable liquids are probably identical with the cell-germs and cells out of which, according to the doctrine of Schleiden and Schwann, all the tissues of the body are developed.

3. My third object is to show in what way the fibrinous granules and vesicles are transformed into corpuscles of purulent matter; and that most probably they are converted also by an analogous process into the red corpuscles of the blood.

4. I shall last of all offer some conjectures as to the mode in which these granules and vesicles originate in the serous fluids.

I do not intend to discuss these subjects in the order in which they are here mentioned, but merely point them out as those, on which the following observations upon the serous fluids containing fibrin are chiefly intended to bear, and which I shall illustrate as opportunity occurs. I begin with the fluid of blisters, as being that which is most easily procured for observation, and which illustrates, in the most striking manner, several of the subjects just enumerated.

IV.—BLISTER LIQUID.

1. *Mode in which Blisters are produced.*—It is well-known that when a cantharides plaster, or other local irritant is applied to the skin, the epidermis is detached from the corium, and raised in a blister. This detachment implies, that the fluid contained in the blister has been poured out with so much force from the surface of the corium, as to rupture all the organic connections between the corium and epidermis. There are no vascular connections between these tissues, but the epidermis is bound down by the ducts of the sudoriparous glands and sebaceous follicles, which must of course be ruptured whenever a blister rises on the skin. The epidermis is also bound down by the hairs, which constitute a much firmer bond of connection, and accordingly, the irritation and other circumstances being the same, it is the number of hairs arising from the surface that determines the size of the blister produced. Hence it is, that blisters upon the head are generally said not to rise, the minute vesications produced occupying only the interstices between the hairs, and not attaining the large size which they often have upon the breast, sides, and other parts less provided with hairs.

2. *Sources of Liquid.*—Whence does the liquid of blisters proceed? As it is formed instantaneously in cases of scalding, it might be supposed to proceed from ruptured vessels, but there is no reason to think that any vessels are ruptured in the process of vesication. The liquid proceeds, in all likelihood, almost entirely from the capillary vessels which are ramified so plentifully on the surface of the skin, and which, when they are distended with blood in inflammation, produce similar vesications. Nevertheless, as the liquid of blisters is not quite identical with the serum of the blood, it is not improbable that a small portion of it may proceed from the large lymphatic vessels on the surface, and from the ruptured ducts of the sudoriparous and sebaceous glands.

3. *Qualities of, and changes which it undergoes.*—The phenomena exhibited by the blister liquid at different periods after effusion, has not, so far as I know, attracted the attention of physiologists. The liquid portion of it has been frequently subjected to chemical analysis, but of the more interesting coagulable portion no notice has been taken. When the blister liquid is drawn off, soon after being effused, it yields a coagulum so small, that it may readily escape observation; when it is not drawn off till later, the coagulum becomes more abundant, and generally the more advanced the period of drawing it off, the more abundant is the coagulum. I once drew off, in a case of burn, about 4 oz. of serum from some large vesications several days old. The serum was perfectly liquid as it flowed into the cup in which I received it; and also some time afterwards, when I transferred it from the cup into a bottle: but on examining it soon thereafter, it

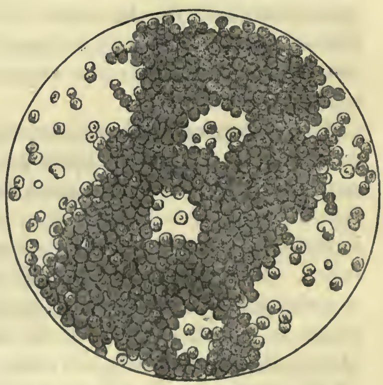
had formed a firm coagulum, occupying at first the whole extent of the liquid, but gradually contracting in size. It may be affirmed, then, in general, that if the vesicated skin has not been so much injured as to interfere with its healthy actions, the blister-liquid always yields a coagulum of fibrin, which becomes more and more abundant, as the blister is the longer unbroken, up to the period when coagulation takes place within the blister itself. This period occurs sooner or later, according to the size of the blister, the vigor of the constitution, and probably other circumstances not yet ascertained. The coagulation is sometimes so complete after the application of a blister during twelve hours, that the liquid drawn off yields little or no fibrin; and sometimes, as in the case just mentioned, the fibrin is not coagulated when the blister is several days old.

4. *Contains microscopic globules, which form coagulum.*—We have thus the process of coagulation taking place in circumstances peculiarly favourable for determining its nature, for we can examine the liquid before, during, and after coagulation, and thus witness all the steps of the process.

When we examine the liquid under the microscope immediately after being withdrawn from the blister, or shortly thereafter, we find it to contain transparent vesicles floating free in the liquid. These vesicles are pretty uniform in size, are nucleolated, and resemble very closely the corpuscles of the blood. (Fig. 1.) Their number varies in different cases. When they are very numerous they speedily attract each other, and run together into a mass of fibrin. This mass is at first distinctly seen to be made up of a congeries of the vesicular corpuscles, (Fig. 2.) but it continues, probably under the influence of

Fig. 1.

Fig. 2.



EXPLANATION OF WOOD-CUTS.

Fig. 1*st*, Appearance of Blister Liquid soon after being drawn off. Vesicles mostly isolated: a few of them coalescent, forming small masses of fibrin.

Fig. 2*d*, A coagulum of Fibrin, in which the vesicular structure is still distinctly visible.

the same attractive power, to diminish in size, and some of the constituent corpuscles contracting more than others, their appearance is variously altered and disguised.

The process of coagulation, then, seems to be a very simple one, consisting in the aggregation of the fibrinous globules and granules diffused through the liquid, by a force perhaps little different from cohesive attraction. The observations recorded below, lead to the same conclusion as to the nature of the process in other instances. In all probability, the reason why the fibrinous globules do not coagulate within the vessels and cavities of the body is, that they are kept in equilibrium by the attraction of the contiguous tissues, which being themselves made up of similar corpuscles, probably possess a similar attractive power; but when the coagulable liquids are withdrawn from the body, the antagonist power is destroyed, and the fibrinous globules, under the influence of mutual attraction, are aggregated into a mass.

If the coagulum first perceived in the blister liquid be removed immediately, free globules will still be observed in the liquid, and by and by a fresh coagulum will form; and thus several successive coagulations may take place, before the liquid is seen altogether deprived of its globules.

5. *Formation of filaments, and reticular tissue in substance of coagulum.*—After complete coagulation, the primary vesicles are no longer observed, their cavities being obliterated, and the membranous parietes converted into short solid filaments, inextricably interwoven with each other. On the first concretion of the fibrinous mass, it is voluminous, extending over the whole space occupied by the constituent vesicles and their interstices. It soon, however, contracts to a smaller size, and the rapidity of the contraction is much accelerated by mechanical agitation, as by drawing the coagulum out of the liquid. After contraction, it has lost its transparency, and has the form of an opaque white membrane or thicker mass. In a thin shred of this mass placed under the microscope, the vesicles of which it at first consisted, are found to have disappeared, leaving a homogeneous structure, of which from its density the constituent filaments are with difficulty perceived. Sometimes again distinct vesicles are seen here and there imbedded in the coagulated mass.

The mode of formation of the reticular tissues, or those which have a basis of cellular membrane, does not appear to me to be, as it has been described by Schwann, by the division of vesicles elongated into filaments. No such process of division is ever seen in the fibrinous vesicles, while every mass of fibrin, from the moment of its formation, seems to affect the reticular form. Instead of this reticular form depending upon the arrangement of the parts of single vesicles, it depends on the arrangement of the vesicles in relation to each other, which, whether they retain their vesicular shape, or what more generally happens, become filamentous, always affect a reticular arrangement. This arrangement is less easily seen under the microscope than with the naked eye. The coagulum of the blister liquid does not show it so distinctly as a loose coagulum, such as that of blood diluted with water before coagulation, or the coagulum which forms in the mixture of the serum of the blood with that of the serous cavities.

6. *Identity of the fibrinous vesicles and granules, with cells and cell-germs.*—The tendency which the fibrinous granules and vesicles have to transform themselves into cellular membrane, appears to me to render it probable, that they are identical with the cell-germs and cells out of which the tissues of the body are developed. According to Dr. Barry, these cells are not distinguishable under the microscope from blood-corpuscles, a character which applies exactly to the vesicles of the blister-liquid.

7. *Conversion of the fibrinous vesicles into Pus globules.*—When the actions going on upon the vesicated surface are of a healthy character, as soon as the fibrinous corpuscles are sufficiently abundant, they concrete into a coagulum. This coagulum hardens into a crust or scab, under the protection of which the epidermis is reproduced, and then the crust falls off. When, on the other hand, the actions are of an unhealthy character, whether from the severity of the original injury, or from the rupture of the blister, and the consequent irritation by the atmospheric air of the raw surface, the fibrinous globules gradually change their colour, and are converted into pus globules. This change seems to be effected by the liquid contained within the membranous vesicles becoming more and more opaque, and as this change of colour takes place, the globules gradually lose their attractive power over each other; hence the globules of laudable pus when examined under the microscope appear perfectly distinct, and have no tendency to aggregation. There are, however, upon all inflamed surfaces globules and granules in every stage of transition, from the transparent fibrinous, to the opaque purulent state. Many of these are more or less adherent, and constitute the flakes and layers of coagulable lymph observed upon inflamed surfaces. When these are examined under the microscope, they are found to consist of corpuscles of various sizes irregularly aggregated, and hence seems to have sprung the notion entertained by some pathologists, that pus globules are formed by the disintegration of globules of fibrin, or of blood; the former of which, from an erroneous theory (as appears to me), of the mode in which they are produced, have been named "*exudation globules.*" This notion is best refuted by observing the steps of the process described above; and also by the size of the great majority of the globules of laudable pus, thus originating, being equal or little inferior to that of the blood globules or of those of fibrin.

With respect to the process by which the transparent liquid within the fibrinous capsules is converted into an opaque one, I believe it to be analogous to the process by which serum exposed to the air is converted into an opaque liquid, which collects at the bottom, and which resembles pus in all its sensible qualities, but consists of irregular flocks instead of globules; and it is not improbable, that some of the less healthy forms of pus which are more flocculent than globular, originate in a similar way within the body.

I believe that pus is never formed, as many maintain, in inflamed vessels and secreted from them. The formation of pus is most distinctly observed in blisters upon the skin, in which we can watch the whole steps of the process, by which effused serum is converted into pus. The same gradual conversion of effused serum into pus is observed in inflamed serous cavities. It may also be observed in the clear liquid which exudes from ulcerated surfaces, and which speedily thickens into pus.

V.—COAGULABLE LYMPH.

The fluid named coagulable lymph, is, probably, in every respect similar to the blister liquid, except in this, that in the latter, one of the two serous elements necessary for the development of the fibrinous corpuscles, is effused in a greatly disproportionate quantity, and hence the production of organized fibrin goes on comparatively slowly. In coagulable lymph, on the other hand, the two elements are effused in exactly the necessary proportions. Organized fibrin is formed therefore with great rapidity, and hence the utility of coagulable lymph in repairing solutions of continuity, and loss of substance of the body. The fibrinous globules developed in coagulable lymph, are either entirely converted into new tissues, as in wounds which heal by the first intention, or simple fractures of the bones; or they are partly converted into granulations and partly into pus, as in healing ulcers and abscesses; or they may be entirely changed into pus of various character, by the process described above. The corpuscles observed in coagulable lymph, vary more in size, and are less regular in form than those of the blister liquid.

VI.—LYMPH OF THE LYMPHATIC SYSTEM.

All those who have observed the lymph drawn from the thoracic duct and lymphatic vessels, describe it as possessing the property of spontaneous coagulability. Gerber represents it as not being coagulable in the extreme lymphatic vessels, and only to acquire that property as it passes towards the heart.

The account given of its appearance under the microscope varies; but most observers agree that it contains corpuscles more minute than the corpuscles of the blood. There is much reason to think, that the description which has been given of it, by one of the most eminent physiologists of the present day, (see Müller's Physiology: Translation, p. 259,) ought to be applied to the coagulable lymph from a small sinus, rather than to the lymph from the lymphatic vessels. Such a sinus might readily form after a wound, and would secrete a fluid which, in its first stage, would have all the characters of coagulable lymph ascribed to it—while our knowledge of the pathological processes that take place in divided vessels, whether blood-vessels or lymph-vessels, is contrary to the supposition that these vessels should continue with patent orifices, after the rest of the wound had closed, pouring out their natural contents. Nothing short of the injection of the lymph-vessels after death, and the demonstration of their open mouths, could establish so improbable a supposition.

VII.—BLOOD.

1. *Contains transparent fibrin, and red globules.*—It is well known that blood soon after being drawn coagulates, and thereafter separates into two parts, the coagulum or solid part, and the serum or liquid part. The coagulum consists chiefly of the red blood corpuscles, but it is universally acknowledged to contain also a portion of colourless fibrin to which the coagulated mass chiefly owes its tenacity. What are the grounds on which this opinion rests? In the first place, as the lymph is continually pouring into the blood from the thoracic duct, the colourless fibrin which the lymph is known to contain must be introduced into the blood. In the second place, in cases of inflammatory disease, and certain other circumstances, the transparent fibrin coagulates separately from the red corpuscles, the latter constituting the lower portion of the coagulated mass, while the former constitutes the upper layer, commonly called the buffy coat of the blood. It may, however, be objected that this is a phenomenon of disease, and that we must show the blood to be similarly constituted in the healthy state. The most conclusive argument then in behalf of the opinion in question is derived from the phenomena observed when liquid blood, as it flows from the arm, is mingled with about eight volumes of serum of blood, when the red corpuscles fall to the bottom, forming a dense layer, and the transparent portion, much more voluminous, occupies the upper part. The same phenomena are seen in a still more beautiful and convincing form, when the transparent fibrin is separated by the filter in a state of perfect purity. I have repeatedly obtained it in this form, although I regret to be obliged to add, that the experiment much more frequently fails than succeeds, and that I have been quite unable to determine on what circumstances the success or failure depends.

2. *Transparent fibrin generally held to exist in solution in the serum of the blood.*—In what state does the transparent fibrin exist in the circulating blood? The generally received opinion is that it exists in a state of solution in the serum, the two together constituting what has been named of late years "*the liquor sanguinis;*" and that the fibrin only passes to the solid state after the blood is drawn, during

the process of coagulation. If this be true, it follows as a consequence, that the two parts into which the blood separates spontaneously after being drawn, are not the same as those of which the blood is seen to consist, by the microscope, when it is circulating in the blood-vessels: for the fibrin, which, in the latter circumstances is united to the solid portion, is, in the former circumstances, dissolved in the liquid portion. It appears to me that the whole of this doctrine is erroneous. I believe the solid and liquid portions, of which the circulating blood is seen to consist, under the microscope, to be the very same as the solid and liquid portions into which the blood, after being drawn, spontaneously separates: that the whole coagulum, or part which affects the solid form after being drawn, existed previously within the blood-vessels in the solid form: that during the coagulation of the blood there is no mysterious precipitation of a solid previously held in solution, bnt that the process of coagulation consists simply here as in the cases already mentioned, in the aggregation of granules and globules previously existing diffused through the serous liquid, but not cohering: and that the only peculiarity in the coagulation of the blood consists in this, that some of the solid corpuscles, by the aggregation of which the coagulum is formed, are red, while others are transparent, and that the latter possess a much higher cohesive power than the former. It follows, if these opinions be correct, that the term "*liquor sanguinis*" should be banished from physiology, as conveying a whole series of erroneous ideas as to the constitution of the blood.

3. *Fibrin exists in the blood, not in solution, but in the form of transparent granules and vesicles.*—In what way can the transparent fibrin which exists in coagulated blood, be shown to exist in the solid form in liquid blood? It may be thought by many that this is a very simple matter to determine; that we have only to put liquid blood under the microscope, when we shall at once be able to distinguish the red from the transparent corpuscles. But all who are in the habit of examining with the microscope the corpuscles in the animal fluids, know that it is only when they are congregated in masses that their colour is perceptible, so that we can determine whether they are red or transparent: but that, when single globules are observed, they are only distinguishable from the surrounding transparent liquid, by their refractive power, which gives to them all the same solar yellow colour, varying in tint according to the intensity of the light under which they are seen. Thus it is, that the transparent corpuscles of blister liquid are in no way distinguishable from red blood corpuscles introduced into it.

It is only by examining the portion of the blood yielding a colourless coagulum, separate from that yielding the red coagulum, that the question at issue can be decided. I have already mentioned the circumstances in which the separation of these two portions of the blood takes place; now in all of these cases, so far as has yet been observed, the liquid yielding the colourless coagulum, is found to contain transparent globules and granules swimming through it previous to coagulation.

This is the case with the milky liquid which collects on the surface of inflammatory blood before coagulating into the buffy coat. This liquid has been shown by several observers (*Medical Gazette,*) to contain innumerable globules before concretion. Still farther, we see in this liquid the same phenomena of successive coagulations which have been described with respect to the blister liquid.

The validity of the opinion here maintained, may be certainly ascertained by examining the liquid which passes through the filter, in the process for separating fibrin, already referred to. I have only once had an opportunity of making this observation, and it was upon a liquid which was not perfectly colourless, owing to a few of the red corpuscles having passed through the filter along with the transparent corpuscles. This liquid contained innumerable granules and globules floating through it, and these cohered together on coagulation taking place.

In a case where the evidence of direct observation is required, it is scarcely admissible to argue from the analogies pointed out in this paper. These analogies, however, are not without weight, while the supposition on which the opposite doctrine is founded, of the sudden precipitation of the fibrin dissolved in the blood, without any change of temperature, or the addition of any chemical reagent, is without parallel in chemistry. It reminds us of the sudden precipitation of the sulphate of soda from its saturated solution, but is much less easily explained.

4. *Vessels in fibrinous coagulum.*—Professor Rainy, of this city, discovered some years ago the interesting fact that the fibrinous coagulum which separates from the blood in cases of aneurism, and occupies a large part of the aneurismal dilatations of the artery, is pervaded by numerous tubes or channels, having an arborescent appearance. These are of such a size, that Dr. Rainy succeeded in introducing a fine needle into one of the larger trunks, thus proving the existence of a cavity in their interior.

(*To be continued.*)

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PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTY-FIRST SESSION, 1842-43.

CONTENTS.

29th March, 1843,—*The* VICE-PRESIDENT *in the Chair.*

XXXIV.—*On the Fibrin contained in the Animal Fluids, the Mode in which it coagulates, and the Transformations which it undergoes. By* ANDREW BUCHANAN, M.D., *Professor of the Institutes of Medicine, University of Glasgow. (Continued.)*

VIII.—MIXTURE OF SERUM OF BLOOD, AND SERUM FROM SEROUS CAVITIES.

Several years ago, I read in this place an account of the singular property which mixtures of the serum of the blood, and serum from cavities lined by serous membranes, possess of undergoing spontaneous coagulation, while neither of the two liquids possesses that property in the separate state. (*Med. Gazette,* 1836. No. 28.) The development of the fibrin does not take place suddenly, like a chemical precipitation, but goes on gradually increasing during several days, like the development of yeast granules in a solution of gluten and sugar. The fibrinous mass is chiefly made up of filaments, but vesicles are also observed in it, although they never attain the full size of the vesicles in the blister liquid. It is in such mixtures that the particles of fibrin are best seen to arrange themselves in the reticular form of cellular tissue. (*Med. Gazette, loc. cit.*)

IX.—ORIGIN OF THE CORPUSCLES CONTAINED IN THE ANIMAL FLUIDS.

The origin of the granules and vesicles contained in the animal fluids is the only subject announced at the commencement of this paper, on which a few observations, are still required.

1. *Not from blood vessels.*—Some physiologists have supposed the fibrinous corpuscles found in effused serous fluids to proceed from the blood vessels, and have therefore named them "exudation corpuscles." The large size of the corpuscles found in the blister liquid, makes it as unlikely, that they should pass through pores in the parietes of the vessels, as the red blood corpuscles which are held incapable of so transuding: and it is not improbable, that there is an attractive power in the tissues which retains the fibrinous particles, even when of smaller size, and thus prevents transudation.

2. *Originate in situations where observed.*—To me it appears much more probable that all the fibrinous corpuscles in the animal fluids, whether contained in cavities or in vessels, originate in the situations where they are observed. This seems to follow as a necessary consequence from the proofs which have been mentioned above, of the power which these corpuscles have of transforming themselves into tissues; for such transformations prove the identity of these corpuscles with the cell-germs and cells, out of which all the tissues of the body are developed. I formerly mentioned the complete resemblance which the vesicles of the blister liquid have to the blood globules; now, according to the researches of Dr. Barry, all the tissues of the body originate in corpuscles not distinguishable under the microscope from blood globules. It can scarcely, therefore, be doubted that the fibrinous corpuscles observed in the animal fluids originate in the situations in which they are observed; where they serve, in the first instance, for the development of the tissues, and subsequently for their redintegration after injury.

3. *Doctrines of Schleiden and Schwann.*—According to Schleiden, the cell-germs of vegetables originate in the interior of the cells. The only instance in which they are observed to be generated on the exterior, is in the formation of the cambium, when they originate in the plastic liquid interposed between the bark and the wood. Now, according to Schwann, the cell-germs of animals always originate in a plastic liquid of this kind, which he names the "cyto-blastema." This plastic liquid he holds to exist both within the cells, and exterior to them, and that in whatever situation the cell-germs are produced, their origin is due to the same action of the plastic liquid. According to this view, we must look for the origin of the fibrinous corpuscles we have been describing, to the liquids in which they swim.

4. *Nature of plastic liquid.*—All organized bodies are developed out of a liquid which presents no visible traces of organization. The first step in this mysterious process appears to be the development in the liquid of granules; next these granules pass into vesicles or cells; and lastly, these cells are transformed into the tissues of the vegetable and animal body. I have described, both to-night and on a former occasion, a liquid derived from the human body possessing these characters. It presents at first no traces of organization, but fibrinous

granules, vesicles, and filaments are gradually developed in it. I shall now endeavour to show that a liquid similarly constituted probably exists in all parts of the body, and is therefore to be regarded as the cyto-blastema, or plastic liquid, which gives origin to the cell-germs and cells, out of which all the tissues of the body are developed.

5. *Origin of, in cavities of body.*—The liquid in which the fibrinous corpuscles have been observed to originate, is a mixture of the serum of the blood with the serum of the serous cavities. The latter differs from the former in chemical composition and qualities.* It consists, most probably, of the serum of the blood, effused from the capillary blood vessels into the interstitial cells of the serous tissue, and there modified by serving for the nutrition of the serous membranes. Now the serous membranes have a basis of gelatin, and are, therefore, similar in constitution to the great majority of the tissues of the body. In all the gelatinous tissues, therefore, the process of nutrition must produce a similar modification of the serum of the blood; and we shall thus have all over the body a liquid produced analogous to the serum of the serous cavities. If, then, the serum of the blood is only effused in the quantity necessary for the purpose of nutrition, it will all undergo the same change, and the modified serous liquid will be absorbed by the blood vessels and lymphatics, to make way for the portion next to be effused. When, however, as in early life, the serum of the blood is poured out in greater abundance than is necessary for the nutritive actions, the excess of it will mingle with the modified liquid in the cavities; and just as in the artificial mixture of these liquids, we shall have a development of cell-germs and cells. Hence the activity of development in early life, and why it keeps pace with the activity of digestion and sanguification; and, as these functions become less active, declines in the same proportion. Hence also the reason why it continues constantly in an active state on the surface of the skin, forming the cells which flatten into the scales of the epidermis, because the effused serum is here always in excess, being only upon one side in contact with a tissue capable of acting upon it, and modifying its composition. Hence also the renewed activity of this function on the occurrence of inflammation, when the increased afflux of blood causes a copious effusion of serum into the cells of the inflamed tissue.

6. *Origin of, in vessels: in healthy state, only in lymphatics.*—The same actions which go on in the shut cavities of the body, go on also in the vessels. These having a basis of gelatin, modify the serum effused, for the purposes of nutrition, into the substance of their parietes, and have thence a supply of the modified liquid poured into their interior; but a much more abundant supply is provided for them by the absorp-

* Dr. R. D. Thomson.

tion of the modified liquid from the cells of the adjacent tissues. In the blood-vessels, the blood moves with such inconceivable rapidity, (the whole mass of blood amounting, in man, to about 20lbs., passing, as is at present believed, over the entire sanguiferous circuit in two minutes,) that there can be little opportunity for the completion of an action in which the mingled liquids require to remain in contact for a length of time. The liquid absorbed into the blood-vessels must be at once hurried onward to the lungs, and other organs of sanguification, by which it may be converted into the matter of the excretions; or possibly by the action of air, and admixture with fresh nutritious matter, it may be reconverted into the serum of blood, which alone, except in rare circumstances, we meet with in the blood-vessels. There cannot, therefore, be any development of cell-germs, and cells in the sanguiferous vessels, in animals whose blood circulates thus rapidly; that is, in any animals of the vertebrated class. But in all such animals, there is provided a supplementary vascular system—the system of lymphatic vessels, into which the serum of the blood passes from the capillary blood-vessels by transudation, while the modified serous liquid is supplied from the sources mentioned above—in which the movement of the fluids is so slow, as to permit the completion of whatever reactions are required for the development of new cell-germs; and which is farther provided with plexuses and glands, which seem still farther intended to facilitate those reactions. It is, therefore, most probably in this system that all the corpuscles of the blood originate: they enter the blood-vessels in a transparent form, and in that state they contribute to the coagulation of the blood, and to the development and renovation of the vascular tissues: while a portion of them is, in all probability, converted into red corpuscles, by a change in the colour and other qualities of the liquid contained in their interior, analogous to the change by which we have seen the same transparent vesicles converted into pus globules.

7. *In inflammation, also in blood-vessels.*—In ordinary circumstances it is probable that no fibrinous corpuscles originate in the sanguiferous system, on account of the rapidity of the motion of the blood: but when that motion is obstructed, as in inflammation, then the same reactions seem to go on in the capillary blood-vessels, as in the cells of the inflamed part, where the organization of the effused fluids is going on with vigour. Hence the production of the buffy coat of the blood. In evidence of this local origin of the buffy coat, I may mention the following observation which I have had twice an opportunity of making. A person labouring under severe whitlow was bled from one of the veins of the affected arm; the blood, in both instances, exhibited the buffy coat in the highest possible degree. In one of the cases, the patient was simultaneously bled from the other arm, and the blood thus obtained showed no buffy coat: but

it must be remarked that the blood from the sound arm was only obtained in small quantity, and had trickled down the arm.

Mr. William Gale explained and illustrated with models, an improved moveable jib crane, designed from the greater security of its construction to prevent those serious accidents which so frequently occur in buildings when the common crane is used.

12*th April,—The* President *in the Chair.*

Mr. Griffin reported the recommendation of the Council that the proceedings of the Society should, for the future, be sold at 3d. per sheet, instead of 6d., as formerly, which was agreed to.

The following papers were read:—

XXXV.—*New Mode of employing Creasote for the Preservation of Butchers'-Meat and Fish.* By John Stenhouse, Ph.D.

Creasote, so named from its great antiseptic power, which exceeds, perhaps, that of any other substance, has been long employed to preserve animal matters from decay. The only two ways in which creasote is usually applied for this purpose, consist either in exposing the meat which we wish to preserve to the smoke of burning wood, of which creasote is the effective constituent, or else in immersing it for a short time in water containing a few drops of creasote. Articles of food prepared by either of these methods may, as is well known, be kept for a long time without spoiling; but both these modes of using the creasote are attended with the inconvenience that the food necessarily acquires the taste and smell peculiar to smoked meat, which is by no means agreeable to every one. By the method now proposed, this inconvenience is entirely avoided.

During the past summer, which was so unusually hot, in common with most persons, I experienced considerable difficulty in preserving fresh meat even for a few days. It struck me at length, however, that perhaps the vapours of creasote might be found useful for this purpose, and the method adopted was the following very simple one. I placed a small plate containing a little creasote immediately under each piece of meat as it hung suspended in the larder, and covered both over with a cloth. The creasote soon gave off vapours which formed an antiseptic atmosphere around the meat, and kept it quite fresh three or four days longer than it would otherwise have been.

If the plate is gently heated before the creasote is put into it, the vapours rise more quickly, and if the additonal precaution is also taken of suspending the meat in a wooden box or earthern jar which can be closed with a lid, the beneficial effect is still more discernible.

I have tried this process during the greater part of last summer with invariable success, and, a butcher, who also tried it on a larger scale in his stall, was equally convinced of its efficacy. The meat, when cooked, has not the slightest smell or taste of creasote.

There is also another advantage attending the use of creasote. Its smell is so disagreeable to flies that it effectually frees a larder from the presence of these noxious insects. The same quantity of creasote may be used for several weeks, but on being long exposed to the air it loses most of its smell, and is partly changed into a species of resin.

Creasote is not a simple proximate principle, as has been supposed, but consists of a mixture of empyreumatic oils, having different boiling points, and containing quantities of carbon, which, from some experiments which I have made, vary so much as from three to four per cent.

XXXVI.—*On the Existence of an Immense Deposit of Chalk in the Northern Provinces of Brazil.* By George Gardner, Esq., F.L.S.

It is well known that the greatest deposit of chalk we have hitherto been acquainted with, is that which is spread over the south-eastern and eastern counties of England, and a large extent of country in the northern parts of France. In Germany and the north of Europe deposits of this formation also occur. No chalk is found in Scotland or Wales, but in Ireland a large detached tract lies under the basalt of Antrim. We have no account, so far as I am aware, of chalk having been found in Africa, India, or Australia. The continent of North America has now been traversed in almost every direction, both by American and European naturalists. The geological structure of its northern parts has been carefully examined by our arctic voyagers and travellers. Humboldt devoted much attention to that of its southern extremity—Mexico; and much of the intermediate portions have been examined by Dr. Morton and other geologists of the United States;—but nothing like chalk with its accompanying flints have hitherto been discovered. The nearest approach to the chalk-formation is that which has been described by Dr. Morton as existing in New Jersey, and which there is every reason to believe is equivalent to the lower or green sand beds of that deposit. Dr. Morton has named this "*The Ferruginous Sand Formation*" of the United States, and describes it as occupying "a great part of the triangular peninsula of New Jersey, formed by the Atlantic and the Delaware and Raritan rivers, and extending across the state of Delaware from near Delaware City to the Chesapeak; appearing again near Annapolis, in Maryland; at Lynch's Creek, in South Carolina; at Cockspur Island, in Georgia; and several places in Alabama, Florida, &c." As a whole, this deposit varies considerably in its mineralogical character; most frequently presenting itself in minute friable grains, with a dull blueish or greenish colour, often with a grey tint. The predominant constituent parts of this marl, as it is termed, are described as silica and iron. But the greatest resemblance which exists between this ferruginous sand formation and the cretaceous rocks of Europe, is the similarity of their fossil remains. Dr. Morton has found it to contain the characteristic fossils of the chalk, particularly *Bacculites* and *Scaphites*, together with *Ammonites*, *Belemnites*, *Echinites*, the *Mososauris*, and *Plesiosaurus*, also univalve and bivalve shells of the same epoch. Among the latter is the well-known *Pecten 5-costatus*, one of the most widely-distributed cretaceous fossils.

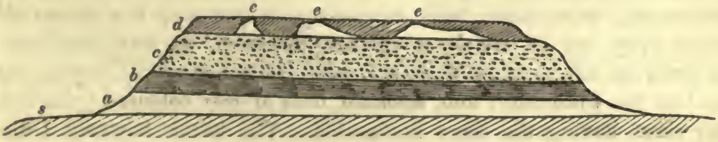
It is asserted by Humboldt that neither oolite nor chalk exist in South America, from the fact that no traveller who has hitherto written on the geology of that immense continent has met with either. The southern, like the northern continent, has now been pretty extensively explored. Humboldt himself made extensive journies on the western, and central parts of its northern extremity; and the same has been done more recently on the eastern side by Schomburg. The chain of the Andes southward has been examined by Col. Hall, Pentland, my friend Mr. Miers, Caldcleugh, Gilles, Pœpig, Darwin, and others. And if we turn to the eastern and central parts of the continent, we will find that they also have been extensively traversed. The southern portions have been well examined by Darwin, Miers, and Caldcleugh. The southern provinces of Brazil have been carefully explored by Spix and Martius, whose travels extended through the central parts of Brazil northward to the district of the Rio Negro, situated between the Amazon and the Oronoco. The mining districts have also been well explored by them, as well as by Von Eschwege, and our countryman Maw. Langsdorf, Burchel, and St. Hilaire, also made extensive journies in the interior of Brazil; and my excellent friend, M. Riedel, the botanist who accompanied Baron Langsdorf, crossed the whole Brazilian empire in a north-west direction to the boundaries of Bolivia, and finally, like Pœpig, descended the Amazon to Pará. But by none of these travellers were any traces of the chalk formation detected.

My own excursions during upwards of five years of nearly incessant travel extended over a vast tract of the Brazilian empire. Although my principal object was to make botanical collections, zoology and geology were not neglected. My geological observations, I may mention, have extended along nearly the whole coast from the equator to the southern tropic; and, inland, from two degrees of south latitude, in a south-west direction, nearly to the western extremity of Brazil, and from thence in a south-east direction through the diamond and gold districts to Rio de Janeiro. The northern provinces of Brazil had hitherto been the least visited by naturalists—indeed several of them of great extent had never been visited at all. These, therefore, I was the most anxious to explore; and richly have I been rewarded by the numerous new plants which I found there, and by the discovery—for the first time on the American Continent—of the whole series of rocks which constitute the chalk formation—of which there are now on the table before us specimens of each, as well as of some of the fossil remains which they contain.

The place where these specimens were obtained is situated in about 80° of south latitude, and 40° of west longitude, or about 300 miles in a straight line from the east coast. The locality forms part of an elevated table land which stretches continuously from the sea coast southward, and forms a natural boundary between the two great provinces of Ceará and Piauhý. It is generally elevated from 500 to 1000 feet above the level of the country to the east of it, but not so much above that to the west; and at the place from whence my specimens were taken is about 2000 feet above the level of the sea. To this range the name of *Serra Vermelha* is given by the Portuguese, and *Ibiapaba* by the Indians. Between the 10th and 11th degrees of latitude it takes a westerly direction, and in about 47° of longitude takes a northerly sweep, finally terminating at the mouth of the Amazon, under the Equator, the country which it surrounds forming a vast valley, including the provinces of Piauhý and Maranham. This elevated range varies very much in breadth, from the branches which run off from it both to the east and to the west. At the place where I crossed it, on my journey westward, it is upwards of 30 miles broad.

The top is perfectly level, forming what the Brazilians call Taboleiras. At Villa do Crato, a rather large town, situated at the base of an eastern branch of the range, called the *Serra de Araripe*, I remained several months in the latter end of 1838 and beginning of 1839, and consequently had ample opportunities for studying not only the Botany, but the Geology of that region. Shortly after I arrived there, I sent home part of the collection of fossil fishes which is now before us, to the care of my much lamented friend, the late J. E. Bowman, Esq., of Manchester. They were exhibited by him at the Meeting of the British Association at Glasgow; and a short notice which accompanied them, giving some account of the circumstances under which they were found, was read by him, and afterwards published in the *Edinburgh New Philosophical Journal* for Jan. 1841. My journeyings and observations after these had been despatched, enabled me to determine much more accurately the nature of the formation to which they belong.

The great mass of this elevated table land consists of a very soft, whitish, yellowish, or reddish coloured sandstone, which in many places must be more than 600 feet thick; and it is in this rock that the fossil fishes are contained. The first thing which led me to suspect that this rock belonged to the chalk formation, was an immense accumulation of flints and septaria, similar to those of the chalk of England, which I found on the acclivity of the range during a journey made along its base to the north of Crato. I now began to inquire if any thing like chalk was to be found in the neighbourhood, and was informed that several pits occurred on the Serra, from whence the inhabitants obtained it for the purpose of white-washing their houses. These pits I afterwards found to be situated in a deep layer of red coloured diluvial clay, which is found immediately over the sandstone of the Serra. In a ravine, near Crato, I endeavoured to ascertain on what rock the sandstone rested, and found it to consist of several layers of more or less compact limestones and marls, with a bed of lignite about two feet thick. What these rested on, I could not at that time ascertain, but some time afterwards when I crossed to the west side of the range, I found these limestones to rest upon a deposit of very dark-red coarse-grained sandstone, abounding in small nodules of ironstone. Thus, then, we find, that the structure of the rocks in this locality are very similar to those of the chalk formation in England. There is



1st. A ferruginous sandstone deposit, equivalent to the lower green sand or Shankland sand, *a*, in the cut, resting on clay slate *s*.

2d. A deposit of marls, soft and compact limestones, and lignite, equivalent to the English galt, *b*.

3d. A very thick deposit of fine grained, soft, variously coloured sandstone, equivalent to the upper green sand of England, containing Ichthyolites, *c*.

4th. The white chalk itself, and flints, occuring in pits *e, e, e*, partially covered by red diluvial clay, *d*.

In none of the chalk pits which I examined myself did I find any flints; but I was informed, that at a considerable distance to the north of Crato, at a part of the Serra called the Serra de Botarité, both chalk and flints are much more abundant than they are near Crato, where they seem to have been nearly washed completely away previous to the deposition of the red clay in which it is now found.

Since the time that the rocks were first deposited at the bottom of the sea, to the present time, both they and the surrounding country must have undergone various changes with respect to elevation; but before making any observations on this subject, I may be allowed to point out the various places where I have seen traces of the chalk formation besides that which I have just described. In 1838, while making a voyage up the Rio San Francisco, which empties itself into the Atlantic between the 10th and 11th degrees of south latitude, I obtained specimens of the sandstone rock on which the Villa de Penedo is built, and these, on comparison, are identical with those from the upper sandstone of Crato. In 1839, I found the ferruginous sandstone of Crato extending westward from thence about 500 miles; and in the year 1841, I found, at Maranham, in 2° of south latitude and 44° of west longitude, a formation very similar to that at Crato. The whole island on which the city of Maranham is built consists of a very dark-red ferruginous sandstone. On the mainland, to the west of it, I found the same rock rising a little above the sea level, but placed immediately upon it there is a deposit, more than 50 feet thick in some places, of a yellowish and greenish coloured sandstone, very soft, and in some places of a marly nature. At Maranham, I neither obtained flints nor fossil remains of any kind.

From these data, then, I think there can be little doubt that the whole of that immense shoulder which forms the most eastern point of the American continent, has at one time been a great depositary for the chalk formation. The only other rocks which I have seen in places which are denuded of those belonging to the chalk are, *first*, gneiss and mica slate, both abounding in garnets, the layers of which crop out in nearly a vertical direction, as was frequently observed on my journey from the coast, and during my voyage up the Rio San Francisco; and, *secondly*, beds of grey coloured primitive clay slate, having the same inclination. The latter, however, I did not observe till within about 18 leagues of the chalk table land. At the termination of these rocks a whitish coarse-grained sandstone makes its appearance, and is probably equivalent to the ferruginous sandstone found on the west side of the range. From this, it would appear, that between the cretaceous series and the primary stratified rocks, there are no traces either of the carboniferous or the oolitic formations, nor in any part of Brazil through which I passed, did I meet with any signs of them.*

The country from the coast to the chalk district is very level, and large tracts of it all the way up consist of what are called Vargems by the Brazilians. These are large open spaces destitute of trees or shrubs for the most part, and only covered with herbaceous vegetation, and that sparingly, during the season of the rains. They are either covered with a kind of coarse white sand, or gravel of various sizes, which gives them the appearance of the dried up bed of an immense river. Much of this gravel consists of flints. Intermingled with these are numerous boulders of various sizes, some of the largest being four feet in diameter. They are all more or less rounded, and consist of granite, gneiss, and quartz. Wherever these gravelly tracts do not exist, the surface of the country is covered with a deposit of the same kind of red clay which lies over the upper sandstone of the table land. To the west of the table land large tracts are covered with the variously shaped ironstone nodules which are found in the ferruginous sandstone, and which have accumulated from the decay of that rock.†

I have now to offer a few remarks on the changes of elevation which this part of the continent has undergone since the chalk rocks were first deposited. That this deposition took place at the bottom of a shallow ocean there can be no doubt. That at some subsequent period it has been gradually elevated above the level of the sea also admits of no doubt. That this elevation has been gradual is evident from the horizontal position of the strata of which the deposit is formed; for had the elevating cause been sudden and violent, the original position of them would not have been so perfectly maintained. The long elevated table-land was probably the first part which emerged from the sea, and for a long period subsequently must have formed a neck of land separating the Atlantic Ocean on the east from the great bay, which the immense valley to the westward must then have formed.

* My friend, Dr. J. Parigot, has, however, found coal abundantly in the island of Santa Catherina, in the south of Brazil. He was employed, about three years ago, to explore that country for coal, and, in a pamphlet which he published, in 1841, entitled "*Memoria Sobre as Minas de Carvaõ de Pedra do Brazil*," he mentions a bed, about three feet thick, of considerable extent. The coal which Spix and Martius inform us exists near Bahia, Dr. Parigot found to be beds of lignite; and the probability is that they are equivalent to that which I found at Crato.

† Sandy nodules with a chalky aspect from this formation were found by Dr. R. D. Thomson to consist of,—

Silica,	76·08
Alumina,	17·32
Water,	6·28
	99·68

We have already seen that the chalk formation at one time must have covered a very great tract of the surrounding country; and we may very reasonably conclude that it was during the gradual elevation of the land that the action of the waves of the ocean as gradually destroyed the soft material of which it had been fabricated. But long after this had been accomplished, and at a comparatively recent geological period, the whole country seems again to have been covered with water,—not only the comparatively level country between the shores of the present sea, and the elevated table-land, but even the highest parts of the table-land itself. This is proved by the thick covering which exists on both of a deep red-coloured diluvial clay, similar to that which I have observed to cover nearly the whole surface of Brazil, from the sea shore to the summits nearly of the highest mountains, and which is often more than forty feet in thickness. When this is cut through it is found to consist of various layers of clay and gravel, in which are embedded rounded stones of various sizes. These have evidently been deposited from water; and in that part of the country of which we are now speaking, this deposition of clay must have taken place at a period subsequent to the denudation of the country to the east and west of the table-land. This could only have been accomplished by the sinking of the land again beneath the level of the sea; and this will also account for the nearly total destruction of the white chalk, as well as for those small cones of it which remain embedded in the red clay—that deposit having been laid down before the whole of the chalk could be washed away. Since then, this part of the continent must have gradually emerged a second time from the bosom of the ocean.

No specimens of the rocks of this formation were sent home to Mr. Bowman along with the fossil fishes; but no sooner did M. Agassiz see them, than from their zoological characters alone, he pronounced them to belong to the chalk series. It is well known that this learned naturalist divides all fishes into four great classes, from the nature of their scales. Two of these, the *Ctenoids* and *Cycloids*, never make their appearance in any of the rocks beneath the chalk, and it was from his knowledge of this fact that he immediately decided my specimens to be from that formation, they consisting principally of *Ctenoids* and *Cycloids*. The fishes, as may be seen from the specimens, are in the most perfect state of preservation, and are contained in an impure fawn-coloured limestone. The blocks, however, in which they are preserved, are only nodules contained in the yellowish coloured sandstone. They have in general somewhat the form of the imbedded fish, and the carbonacious matter has apparently aggregated round it by chemical attraction from the sandstone while in a soft state. These nodules being harder than the sandstone, have by its gradual decay accumulated at various places along the acclivity of the range, and I possess specimens both from the east and the west side of it. The fishes were found by M. Agassiz to be all new, and he has appended to my paper, in the *New Philosophical Journal*, a short description of them. Here I shall do little more than enumerate the species.

I.—GANOIDS.

1. *Aspidorhynchus Comptoni*, Agass. Near to *A. Cinctus* of the Kentish chalk.

2. *Lepidotus temnurus*, Agass. Also nearly allied to a species from the chalk of Kent.

II.—CTENOIDS.

1. *Rhacolepis.* This is a new genus, and differs from all the others of the group to which it belongs, by the single dorsal fin having no spinous ray; and by the ventral being placed on the middle of the abdomen. There are three species,—*Rh. latus*, Agass.; *Rh. buccalis*, Agass.; and *Rh. Brama*, Agass.

III.—CYCLOIDS.

1. *Cladocyclus Gardneri*, Agass. A scale, published by Agassiz, from the Kentish chalk, and supposed by him to belong to his genus *Hypsodon*, is the scale of a Cladocyclus.

2. *Calamopleurus cylindricus*, Agass.

I also possess, from the same rocks, specimens of two species of very minute bivalve shells, a single valve of a venus, and casts of a univalve shell, all apparently new.

Dr. R. D. Thomson presented to the Society the Third and Fourth Annual Reports of the Registrar-General of Births, Deaths, and Marriages, for 1841 and 1842.

He also read the following Report, which was adopted, and ordered to be inserted in the Proceedings of the Society.

XXXVII.—*Report on the State of Disease in Scotland.*

The Committee appointed to consider the best means of improving the state of Vital Statistics in Scotland, and the consequent sanatory condition of the inhabitants, beg to submit the following Report to the consideration of the Philosophical Society:—

The Committee believe that it is scarcely necessary for them to offer an apology while directing the Society's attention to that most important of all scientific questions—the sanatory condition of the people. For, if the opinion of one of our soundest philosophers be correct, that the greatness of a country depends on its population—and if the object of practical science be the discovery of those truths which tend to the comfort and happiness of the people—then it is unquestionable that a legitimate application of science is the discovery and prevention of those causes which diminish the population, or which render it unhealthy and miserable.

The admirable system of registration of deaths in England and Wales, by classifying the causes of mortality in every locality, has already enabled those who direct its machinery to point out methods of staying the hand of death. For example, in 1837, the first year in which the registration act came into operation, the mortality from *Small-Pox,* in London alone, amounted to about 1520 persons, equivalent to a loss of 4¼ human beings *daily.* The attention of the Legislature was drawn to this fact by the Registrar-General—and the result was the enactment of the *Vaccination Act,* extending to England and Wales, after which the mortality was reduced from 1520, in 1837, to 360, in 1842, in the metropolis—and from 16,268, in 1838, to 10,434, in 1840, over the whole of England and Wales.

Such being the results of a registration act, it is important to compare them with Glasgow, where no such legislative enactment is in operation, as is shown in the following table:—(*Reg. Gen. Rep. Glasg. Mort. Bill.*)

DEATHS FROM SMALL POX.

	Glasgow. Population. 282,134	London. Population. 1,875,493	
1838, . .	388 . .	3,090	Epidemic.
1839, . .	406 . .	634	An epidemic diminishes the mortality in the following year.
1840, . .	413 . .	1,233	
1841, . .	347 . .	1,053	
1842, . .	334 . .	360	

Mean, 377, or about *one inhabitant daily,* dies of small-pox in Glasgow.

Thus, although the population of London is upwards of 6½ times that of Glasgow, the mortality, in 1842, from small-pox, was nearly the same in the two cities. We believe there cannot be a doubt that the remarkable diminution in the mortality from small-pox in London is mainly attributable to the introduction of the vaccination act, and that the extension of a similar law to Scotland would be attended with the happiest benefits to the community. The total mortality in Glasgow from all diseases being about 24 persons daily, the *universal* adoption of vaccination would save from a hideously cruel death one twenty-fourth of all who die.

Another result, from correct registration, has been the deduction, by vital statisticians, that in epidemic diseases, such as small-pox and cholera, the influence of medical treatment, even when conducted on the most judicious principles, is comparatively insignificant in altering the *average* mortality; and that it is, therefore, scarcely speaking too strongly to affirm, that out of a given number who are taken sick, a certain number are doomed to die. Hence the importance of adopting measures for the prevention of acute diseases, of which the New Drainage Bill (one of the results of the English Registration Bill,) is a happy example. In order to detect the causes of diseases, the mortality bills would require to be made up weekly—at least in large towns. By such a regulation, we might expect some light to be ultimately shed on the origin of Typhus fever in Glasgow—a disease whose ravages are quite appalling, when we compare it with the mortality from the same disease in the metropolis, as appears from the following numbers:—

DEATHS FROM TYPHUS.

	GLASGOW.	LONDON.
1838, ...	816	4078
1839, ...	539	1819
1840, ...	1229	1262
1841, ...	1117	1157

The mortality from this disease, in Glasgow, was, therefore, in 1841, $3\frac{1}{4}$ per day—equivalent to above $\frac{1}{8}$ of the whole mortality.

In earnestly calling attention to the dreadful mortality from the two diseases mentioned, the Committee feel strongly the importance of introducing into Scotland a more correct system of registration than that at present in use.

To draw the attention of those who have the power to take measures for saving human life, to such facts as the preceding, is, in the opinion of the Committee, the duty of a scientific society.

The Committee, appreciating the many advantages which would result from the introduction of an uniform system of Registration of the Births, Marriages, and Deaths, in the three divisions of the United Kingdom, beg to suggest, as a prelude to a general legislative enactment, that hospital physicians and surgeons, and district surgeons, and all public medical officers, should make their return of Deaths in the form of the printed schedule now in use throughout England and Wales.

The Committee would also suggest the importance of a more frequent publication of the results of registration. By a weekly, monthly, or quarterly bill of mortality, the registration reports would be susceptible of much greater accuracy;—diseases might be traced with increased facility to their proper causes, the labour of drawing up the mortality bills would be rendered less irksome, and a series of documents, of great practical value, would be continually submitted to the attention of men of science, and of the public.

26th April,—The PRESIDENT *in the Chair.*

XXXVIII.—*Remarks on the Comet of March*, 1843. By WILLIAM GOURLIE, Jun., Esq.

MR. LIDDELL, in his interesting account of the Philosophical Society, states, that since its formation, in 1802, almost every discovery and new or striking phenomenon in physical science has been brought under review at the meetings; and since this has been the case, I do not think it would be right to allow the late most remarkable comet to fade from our remembrance as rapidly as it has done from our vision, without recording in the Minutes of the Society the fact of its short visit to the centre of our solar system.

The faint luminous streak which attracted the attention of astronomers about the middle of last March, although by no means conspicuous, was at once inferred, by Sir John Herschell and others, to be the tail of an immense comet, the nucleus of which was below the horizon. The fact of its early discovery shows the close and persevering attention with which our astronomers continually scan the heavens, whilst their accurate conjecture as to its nature equally exhibits the great knowledge of astronomical phenomena, which has resulted from the labours of men who have devoted the most brilliant talents to this sublime science.

There were not wanting those who laughed at the idea of such an enormous tail (70 degrees) as preposterous, and it was astonishing to find it referred to the zodiacal light by observers, who, if they really saw it, as they alleged, ought to have known better. Believing that very few in Glasgow had an opportunity of seeing it, I have taken the liberty of bringing it under the notice of the Society, for the purpose of describing the position of the tail, as I observed it on the evenings of Saturday the 25th and Sunday the 26th of March, about 8 o'clock, as much confusion seems to exist, amongst people generally, as to what *was*, and what was not the tail. It so happened that the zodiacal light was unusually well seen last month, and the corruscations of the *aurora borealis* were also of frequent occurrence.

This comet, which seems to be quite a new one, was first observed in England by Mr. Short, of Christ Church, Hants, on the 16th, and by Sir John Herschell on the 17th of March, and the latter distinguished astronomer immediately communicated his observations to the "Times." It was simultaneously observed by Professor Arago and others in Paris, and at a much earlier date, in the south of Europe. The length of the luminous matter forming the tail has been estimated at about 70 degrees; more than 45 degrees were measurable above our horizon, extending from the constellation Lepus through Fluvius Eridanos, and becoming lost in the haze above the horizon; at Yale

College it was traced to the star τ Ceti. Before looking for it, I traced its position, as described by Sir John Herschell, on a celestial map, and having mentally fixed its locality, had little difficulty in finding it with the naked eye, in the south-west passing immediately under the stars γ and β Orionis, between γ and δ Eridani, and losing itself in the haze.

As the zodiacal light has a totally different position, "invariably appearing in the zodiac, or more correctly in the plane of the sun's equator, I do not understand," says Sir John Herschell, "how it is possible for any one familiar with the zodiacal light, for an instant to confound them. It exhibits generally the appearance of a pretty broad pyramidal or lenticular body of light, which begins to be visible as soon as twilight decays, most luminous at the base, which, resting on the horizon, has an angular breadth of 10 or 12 degrees in ordinary clear weather; whilst its axis at the vernal equinox is always inclined (to the northward of the equator,) at an angle of between 60 and 70 degrees to the horizon; and it is generally traceable as high as the Pleiades. The tail of the comet had on the contrary a breadth of not more than 1½ degrees, was inclined at an angle of not more than 25 deg. to the horizon, and that not to the north but to the south of the equator, did not increase in intensity towards the horizon, and made an angle of 33 deg. with the zodiac to the southward, instead of 7 deg. to the northward of that circle."

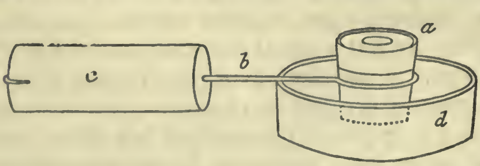
The following is a graphic account of its appearance from Demerara, and is an extract of a letter from my friend William Hunter Campbell, Esq., LL.D., dated Georgetown, 18th March, 1843:—

"P.S.—18*th March*.—It may be no news to you, but in order to compare notes I must tell you that we have at present in our horizon a most magnificent comet, the finest I ever saw or ever expect to see again. It was first noticed on the evening of the 3d instant. It is seen in the south-west, and seems gradually rising from the horizon. Its length is prodigious, appearing to extend over 30 or 40 degrees of the heavens, and the body and tail present an immense train, luminous and bright, varying from one and a half to twice the apparent diameter of the moon. The nucleus is very readily seen with an ordinary telescope, appearing of a ruddy hue, and like a second or third-rate star in magnitude. Remembering that about this season Orion is not seen or conspicuous in England, I am doubtful whether the comet may be visible there either, for last night it was seen in all its glory, with the tail close on Orion. It has been an object of great interest to us all here, but unfortunately we have no observatory nor scientific astronomers, all of which I envy you if the wanderer has visited your regions. I do not think it has been announced by any astronomical almanac, for if it had it is too immense and wonderful not to have been long ere now the subject of conversation in the scientific world. At first, the people here were frightened at it, thinking it too large for a comet, and imagining it a lunar rainbow or some gigantic meteor before unheard of. It is no unapt representation of what one might imagine the pillar of fire to have been which guided the Israelites of old in the wilderness. As to its being a lunar rainbow, the idea was preposterous, for it bears not the most remote resemblance to one, nor forms the slightest segment of a circle; besides, it happened to be situated, as regards the moon, in a totally different direction from that in which a rainbow would have been. Last night it was very bright, the heavens being beautifully clear and unclouded, and the moon not having risen at eight o'clock, her rays did not detract from its brightness."

XXXIX.—*On a New Kind of Charcoal Support for Blowpipe Experiments.* By JOHN JOSEPH GRIFFIN.

SEVERAL of the most important experiments performed with the Blowpipe, require the assistance of charcoal, upon which the object submitted to examination, is supported in the flame. The charcoal employed for this purpose should be of soft wood, well burnt, compact, and free from crevices. Such charcoal is difficult to obtain. I have several times examined a sackful of charcoal, without finding above half-a-dozen sticks adapted for these experiments. This circumstance induced me to seek for a substitute, and having found one which seems likely to prove serviceable, I think it possible that other persons accustomed to operate with the Blowpipe, and accustomed also to feel the want of suitable charcoal, may be willing to learn in what manner they can easily replace it by an efficient substitute. For this reason I have drawn up the following notice.

The Blowpipe experiments that require the assistance of charcoal, may be divided into two classes:—In the first class may be named, the formation of beads with microcosmic salt, the trial of fusibility *per se*, and the roasting of the metallic compounds that contain such volatile elements as sulphur and arsenic. The second class of experiments is restricted to the fusion of minerals or metallic compounds with carbonate of soda, or with soda and borax, for the purpose of effecting particular combinations or of procuring their metals in the state of regulus. For these two classes of experiments, I make use of two different composition supports the first of which I shall call *Supports for Fusions*, and the second *Supports for Reductions*.



These are alike in appearance—the form and size of both being shown by fig. *a*. Each consists of two parts, an upper or combustible portion, and a base or incombustible portion. The former is the proper substitute for the ordinary charcoal, the under portion only acting as a crucible in which the combustible portion is contained. I shall first describe the composition and formation of the supports, and afterwards show the way to use them.

The incombustible portion of both supports is made of fine pipe-clay and charcoal powder, mixed in equal parts by weight, with as much water, slightly thickened by rice paste, as is sufficient to form a stiff plastic mass.

The combustible portion of the *Support for Fusions* consist of

Charcoal in fine Powder, . .	12	Parts.
Rice Flour, ...	½	—
Water, ...	about 8	—

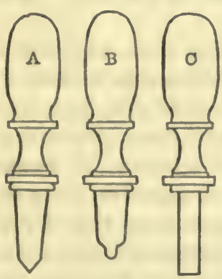
The rice is boiled in the water to form a paste, with which the charcoal is afterwards mixed into a mass of the consistence of dough.

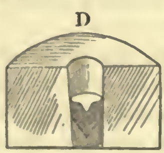
The upper part of the *Support for Reductions* consists of the following mixture:—

Charcoal in fine Powder, . .	9	Parts.
Carbonate of Soda, crystallized,	2	—
Borax, crystallized, . . .	1	—
Rice Flour, ...	½	—
Water, ...	about 8	—

The water is boiled, the soda and borax are dissolved in it, and the rice is then added to form a paste, with which the charcoal is finally incorporated, and the whole well kneaded into a stiff mass.

The mould in which these compositions are pressed to form the supports, is made of box-wood, and consists of four pieces, represented by figs. A, B, C, D.





D is a cylindrical block, having a conical hole through the centre; A, B, C, are pestles or stampers fitted to this hole. The mould, D, when in use, is set upon a clean surface of iron, such as a Blowpipe anvil. A round ball of the clay composition, ¼ inch in diameter, is put into it, and pressed to the bottom by means of the pestle A. This forms a conical cup or crucible similar to the under portion of fig. E, which represents a vertical section of a support. A round ball of the combustible composition, of either kind, ⅓ inch in diameter, is next put into the mould, and pressed firmly down with the pestle B, and the pestle, before being withdrawn, is gently turned round to smooth the surface of the support. The mould is now lifted from the anvil, and the pestle C is applied below to push the support out of the hole.

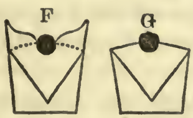
The principal points which require attention, to ensure success in this process, are, to have the materials in the state of very fine powder, and the moist compositions of a proper degree of consistency. If they are too soft, the support will not quit the mould without losing its form. If too dry, the particles of the support will not cohere. The proper state is found after a few trials. It is most convenient to begin by making the mixture too soft, and then drying it slowly till found to be hard enough to work easily. The composition is rolled into little balls of the size before mentioned by means of the fingers. The moulds should be kept clean, and the forming parts of the pestle B and the ring D should be oiled. The best way to clean the hole in the mould D is by means of a long conical cork, rasped to a rough surface and oiled. The point of the pestle A must not be oiled, because grease prevents the adhesion of the combustible portion of the support to its clay base.

When the support is taken from the mould it is put on a hot plate or a sand bath to dry, after which, the rough edges are taken off by a rasp. It is then ready for use. The bottoms of the supports for reductions are painted with red ochre mixed with rice paste, to distinguish them from the other kind. The size I have fixed upon is as follows:—height $\frac{1}{2}$ inch, diameter at the top $\frac{1}{2}$ inch, at the bottom $\frac{2}{5}$ inch. The weight is about 16 grains, consisting of 10 grains of clay crucible, and 6 grains of combustible matter. I have tried several other sizes, but find this to be the most generally convenient. Nevertheless, a higher temperature can be produced upon a smaller support, and I find that large masses of charcoal are not essential, since many blowpipe experiments can be finished during the combustion of only two grains of charcoal.

Before I proceed to explain the mode of using these supports, I must describe the handle by means of which they are to be held in the blowpipe flame. This handle consists of an iron wire, $3\frac{1}{2}$ inches long and $\frac{1}{30}$ inch in diameter, one end of which is bent into a ring about $\frac{2}{5}$ inch in diameter, while an inch of the other end is forced through a round cork 1 inch long and $\frac{1}{3}$ inch in diameter, as represented by figs. *b*, *c*. The operator fixes the support in the ring of this wire, and holds it by the cork handle, which is intended, not so much to protect the fingers from heat, as to provide the power of varying the position of the support in the flame, as the progress of an ignition may require.

I shall now describe one or two experiments which show the method of using these supports.

1). The surface of one of the *Supports for Fusions* is heated before the blowpipe till it is red hot. If then removed from the blowpipe flame, the support continues to burn, like an ordinary pastile, till it is consumed down to the clay. In this respect, the support has a superiority over ordinary charcoal, which soon ceases to burn when removed from the fire. The ignited support is to be rested on a porcelain capsule in the manner represented by fig. *d*, and a quantity of microcosmic salt, sufficient to form a bead, is placed upon its red hot surface. The salt instantly smelts and sinks into the central cavity, so as to form a bead, fig. F, the heat, the form, and the smoothness of the surface of the support, facilitating this part of the process. The salt is then heated before the blowpipe till it is melted into a transparent colourless bead. The support is again placed on the porcelain capsule, and the metallic substance intended to be incorporated in the bead, is added to it. The support continuing to be red hot, and the bead consequently continuing soft, the substance so added is immediately absorbed and its loss by dispersion prevented. Whereas, upon common charcoal, the fused salt solidifies soon after it is removed from the flame, and the substance added for examination, not adhering to it, is often blown away by the first blast from the blowpipe jet. The bead is now again fused till the substance added to it is decomposed, and the resulting glass is observed to fuse quietly. It is then ready for examination, but it is sunk in the bottom of the hollow in the support, (see fig. F,) and cannot be seen by transmitted light unless the projecting sides of the support be removed. This is effected as follows:—The support is placed as before upon the procelain capsule, and the operator blows with his mouth, without using the blowpipe, strongly down upon its surface. The pastile then burns away rapidly, and the force of the blast of air disperses the ashes, until the whole rim of the support is consumed, down to the part marked, in fig. F, with dotted lines. The bead then appears situated on the summit of a cone, as shown in fig. G, and can be examined either by reflective or transmitted light. It is also in a position adapted for exposure to the different action of the oxidating and reducing flames, so as to have the character of the included metal fully developed. If, finally, the charcoal is allowed to burn wholly away, the coloured bead can be lifted from the ashes and preserved in a closed glass tube for subsequent examination and comparison.



2). If the surface of one of the *Supports for Reductions* is heated before the blowpipe, it burns at first like the simple charcoal support, but in proportion as the charcoal is consumed, the fluxes which were mixed with it, and which are not volatile, concentrate and fuse upon the surface of the residue. If, therefore, a reducible metallic compound is heated upon such a support, it becomes exposed at once to the reducing action of the high temperature, of the nascent oxide of carbon, and of the carbonate of soda, whilst any earthy matter that it may contain is vitrified by the attendant borax. It is easy therefore to conceive that these supports should possess a powerful reducing action, and so in fact they do. For example, a crystal of sulphate of copper, as large as the surface of a support, can be decomposed upon it, and all its elements be driven off except the copper, which is finally obtained in a single metallic bead. A globule of metallic tin, an eighth of an inch in diameter, can be kept boiling upon a support without being converted into oxide. A crystal of quartz can be fused into soda glass. Flint glass can be melted with metallic oxides, in such quantities as to form beads of enamel or coloured glass the sixth of an inch in diameter. And these effects are producible upon a support of the weight of only 16 grains, and during the combustion of perhaps not more than 3 or 4 grains of charcoal. Indeed, many striking results are produced by a combustion of only 2 grains of charcoal, but then this combustion is effected under very favourable circumstances, where very little more charcoal is heated than is intended to be burnt, and where no more is burnt than is required to produce the intended effect.

This power of restricting the consumption of charcoal in such experiments, is a merit which will render these composition supports acceptable to travelling mineralogists. Berzelius laments the difficulty of procuring good charcoal when travelling, even in the well-wooded regions of the north, and this difficulty, and the consequent necessity of carrying about a quantity of charcoal, all travelling analysts must find an annoyance. But as the supports which I have described, require for each only a cube of ¼ of an inch of charcoal, it follows that a sufficiency of either mixture, for no less than 500 experiments, may be carried in a square tin box measuring only two inches on each side. Moreover, the incombustible portion of the supports can be pounded down and remoulded any number of times, so that only a very small quantity of clay is requisite.

3). The last blowpipe experiment to which I shall now allude is cupellation, the performance of which before the blowpipe, is considerably facilitated by the apparatus described in this notice. When a cupellation is to be effected, a clay crucible is made in the mould D, by means of the pestle A, in the manner already described, and into this crucible a quantity of moistened bone ashes is pressed by the pestle B, so as to make a cupel similar in form to a charcoal support, fig. E, but consisting of bone ashes. This cupel being mounted upon the wire handle, shown by figs. *b*, *c*, is ready for use. A much higher temperature can be raised upon such a cupel than upon the same quantity of bone ashes placed, as usual, in a hole cut in a large piece of common charcoal.

I have now only to state my reasons for choosing rice as an ingredient of these pastile supports. They are, that rice paste is a strong, cheap, and convenient agglutinant; that when heated before the blowpipe it melts and binds the charcoal powder well together; that when decomposed, its charcoal is very difficult of incineration; and that its ashes are neither more abundant nor more troublesome than those of wood charcoal that forms the mass of the support. These properties enable us to give to charcoal powder any desirable form, and to bind it firmly together, without the intermixture of any impurity. Other agglutinants do not possess the same combination of good properties. Thus, gum arabic is sixteen times as dear, it intumesces under ignition so much as often to disrupt the charcoal pastile, and its ashes shine at a high temperature with such intense brilliancy, as to dazzle the eyes of the operator, and make analytical observations impossible.

It is probable that rice would form an excellent ingredient in the mixture for Charcoal Galvanic Batteries.

XL.—*On the Nutritive Power of Bread and Flour of different Countries.* By ROBERT D. THOMSON, M.D.

IT was observed as early as 1742, by Beccaria of Bologna, in Italy, that flour consisted of two parts differing essentially in their nature; the starchy part affording, by distillation and digestion, principles similar to those of all vegetables, and the glutinous part, on the other hand, supplying substances similar to those derived from an animal origin.* This discovery constituted the basis of all subsequent researches into the nature and effects of flour as an article of nourishment. Indeed, until 1820, Beccaria's method of analysing flour was the only one practised by chemists. In that year, however, Taddey, another Italian chemist, showed that gluten might be separated into two parts by treatment with alcohol—he kneaded the gluten with successive portions of alcohol as long as the latter fluid became milky with water. The alcoholic solution gradually deposited by standing *gliadine,* while *zumome* remained unacted on by the alcohol. The gliadine of Taddey was examined also by Saussure and called *Mucin.* If this substance be separated by filtration and the liquor be evaporated, a body termed *Kleber* by Einhoff, and glutin by Saussure, remains; while the substance which is untouched by the alcohol is denominated albumen, or at present fibrin. The present method of analysing flour, is to dissolve the gum, sugar, and albumen, by means of water, the flour being placed in a linen bag or towel and exposed to pressure, so as to force out the starch, and leave the glutinous portion on the cloth. The latter when treated with alcohol affords casein, glutin, oil, and fibrin which remains undissolved. According to the present views of chemists, those substances which contain azote are alone capable of forming blood, or in common language, of nourishing the body. It is obvious therefore, that as the azotized principles of flour, viz. albumen, fibrin, casein, and glutin, each contain the same quantity of azote, or 16 per cent., the determination of the amount of this element present in flour, affords us at once an index of the nutritive power of flour or bread; on this principle the following table

* Collection Academique, tome xiv., p. 1.

has been constructed. The azote was obtained by converting it into ammonia and precipitating by bichloride of platinum.

The Naumburg bread—a town in the south of Prussia, situated in a fine corn country—the Dresden and Berlin bread, were obtained by myself in these cities in August 1842. The flour was probably, therefore, grown in 1841. The other specimens were procured in the early part of the present year, and are probably of the growth of 1842. The second column gives the quantity of platinum obtained in the experiments from which the third column has been calculated. The fourth column gives the relative value; 100 of Naumburg being equivalent to 115⅓ of Dresden bread.

	Quantity Analysed.	Platinum.	Azotized Principles. Per Cent.	Equivalents.
Naumburg Bread, ...	10 grs.	1·81 grs.	16·49	100·00
Dresden do.	—	1·57	14·30	115·31
Berlin do.	—	1·56	14·21	116·04
Canada Flour, ...	9·9	1·50	13·81	117·23
Essex do.	9·1	1·30	13·59	121·33
Glasgow unfermented Bread,	10·0	1·47	13·39	123·15
Lothian Flour, ...	—	1·35	12·30	134·06
United States Flour, . . .	—	1·25	11·37	145·03
Ditto by mechanical analysis, ...			10·99	150·00

The low position of the American flour as indicated by the first experiment in the table, was so startling, that it was repeated by means of the mechanical process. The result of the analysis of three ounces was as follows:—

				Per Cent.
Starch, ...			902·00	68·73
Gluten,	Fibrin, ...	116·80	130·40	9·93
	Casein, ...	5·27		
	Glutin and Oil, .	3·04		
	Loss, (Water) .	5·29		
Albumen, ...			14·00	1·06
Gum, ...			60·40	4·60
Sugar, ...			16·30	1·24
Water, ...			189·40	14·44
		3 oz. =	1312·50	100·00

It is from this analysis that the second result is given in the table. It affords a striking confirmation of the accuracy of the first determination. It is only necessary to add that all these specimens were dried at the temperature of 212° before being subjected to experiment.

BELL AND BAIN, PRINTERS, GLASGOW.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTY-SECOND SESSION, 1843-44.

CONTENTS.

1*st November*, 1843,—*The* President *in the Chair.*

Mr. John Watt was elected a Member of the Society.

Mr. Gourlie, in the absence of Dr. Balfour, presented the Transactions, Laws, and Regulations of the Botanical Society of Edinburgh, on the part of that body. The Secretary was requested to return the thanks of the Society to the Edinburgh Botanical Society for their donation. The Vice-President having taken the Chair, Dr. Thomson read the following paper.

XLI.—*On Coal Gas. By* Thomas Thomson, M.D., F.R.S., L. & E., M.R.I.A., *Regius Professor of Chemistry.*

It is well known that the word *Gas* was first introduced into chemistry by Van Helmont, in his *Treatise de Flatibus.* Junker, whose *Conspectus Chemiæ Theoretico Practicæ* was published in 1744, conjectures that Van Helmont's word gas was merely the German word *Gäscht*, fermentation in a Latin dress, and this conjecture seems as probable as any.

Boyle was the first chemist who attempted to make gas artificially, and who showed that thus prepared it possessed the mechanical properties of common air. The gas which he examined was hydrogen, obtained by pouring dilute sulphuric acid on iron filings.

Hales, in 1726, proved by experiment, that many animal and vegetable substances, when heated sufficiently, give out an air which possesses the mechanical properties of common air, and which, therefore, he considered as not differing in its properties from common air. That hydrogen gas was combustible, was known at least as early as the beginning of the last century; and many remarkable stories are told by early chemists of the eighteenth century about its combustibility, and the violent explosions which a mixture of it and common air produced when brought in contact with a burning body.

Dr. Black first showed, that carbonic acid, though a gas, differed essentially from common air, and he gave it the name of *fixed air*, because it existed in a solid state in the carbonates. Cavendish, in 1766, showed that hydrogen differs from common air and from carbonic acid. He examined its combustibility, its specific gravity, and its peculiarities. In 1772, Dr. Priestley began his experiments on air. First he examined carbonic acid and hydrogen; then azotic gas, then deutoxide of azote, muriatic acid gas, and ammoniacal gas. In 1774 he discovered sulphurous acid gas and oxygen gas, which was destined to make such an alteration in the chemical theories of the time. He discovered fluoric acid gas and carbonic oxide, though he was not aware of its peculiar nature, and, indeed, remained ignorant of it to the end of his life.

It is curious that Dr. Priestley no where, so far as I know, mentions carburetted hydrogen, or heavy inflammable air, as it was then called. It constitutes the *fire damp* of coal mines. Its combustibility, and its property of exploding with great violence in certain circumstances, must have been known in coal countries at a pretty early period. In the Philosophical Transactions for 1667, there is an account of a blower of this gas passing through and taking fire from the flame of a candle and burning briskly; and in the same work, there are many histories of explosions in coal mines, attended with the loss of many lives.

Though carburetted hydrogen occurs so commonly in coal mines, and though it burns with a strong flame and gives out a good deal of light, and although it had been ascertained that when common coal was distilled at a red heat it gave out a great deal of inflammable gas —it does not seem to have occurred to any person to employ it as a substitute for candles, till the idea struck Mr. Murdoch, an Ayrshire gentleman in the employ of Watt & Boulton. In the year 1808, he published a paper in the Philosophical Transactions, pointing out the advantages that would result from employing coal gas instead of oil for illuminating the streets of towns and manufactories.

In this paper he gives an account of the apparatus which he had fitted up for lighting the cotton manufactory of Messrs. Phillips & Lee at Manchester, which was at that time the greatest cotton mill in the kingdom. He shows that the expense was only about one-fourth of that of the candles or oil necessary to produce the same quantity of light that the gas did. The coal used was the best Wigan cannel, a ton of which, he says, yields 7160 cubic feet of gas, and produces about two-thirds of a ton of coke.

In this interesting paper, Mr. Murdoch gives the history of the discovery of gas making. In the year 1792, while at Redruth in Cornwall, he made a set of experiments on the quantity and qualities of the gases produced by distillation from different mineral and vegetable substances. He was induced, by some observations which he had previously made on the burning of coal, to try the combustible properties of the gases produced from it, as well as from peat, wood, and other inflammable substances; and being struck with the great quantities of gas which they afforded, as well as with the brilliancy of the light, and the facility of its production, he instituted several experiments, with a view of ascertaining the cost at which it might be obtained, compared with that of an equal quantity of light yielded by oils or tallow.

In the year 1798 he removed from Cornwall to Boulton & Watt's works at Soho, and there he constructed an apparatus upon a larger scale, which, during many successive nights, was applied to the lighting of their principal building, and various new modes were tried for washing and purifying the gas. These experiments were continued, with some interruptions, till the peace of 1802, when a public display of the gas light was made by him in the illumination of the manufactory at Soho on that occasion.

Since that period, or between it and 1808, he extended the apparatus at Soho, so as to give light to all the principal shops, where it was in regular use, to the exclusion of other artificial light. In 1808 he fitted up the gas apparatus in Messrs. Phillips & Lee's cotton mill; since which time it has been extended to all the cotton mills in the kingdom.

I have stated these details, though but imperfectly connected with the subject which I mean to discuss, because I believe the history of the introduction of gas, as a substitute for oil or candles, is not very generally known. It is generally ascribed to Mr. Windsor, who took out a patent in 1806, and who delivered lectures on the subject several years after, and who endeavoured to get up a joint-stock company, with what success I do not know. Several attempts were made here about the year 1808, and during the winter of that year the front of the Tontine buildings at the Cross of Glasgow was lighted with gas for several weeks. London was the first city illuminated with gas. Philip Taylor erected the gas works at Paris soon after the peace of 1815.

In the preceding historical sketch, I have taken no notice of Lord Dundonald's coal tar works at Culross. The current of gas escaping from his ovens was frequently fired; but it does not seem to have occurred to him to employ the gas thus extricated for economical purposes. Nor have I noticed M. Lebon, who is said, in 1786, to have attempted, but without success, to employ gas distilled from wood as a substitute for candles. These attempts led to no results, and were speedily forgotten.

There are four varieties of coal which have been tried in Great Britain in the manufacture of gas; namely, caking coal, cherry coal, splint coal, and cannel coal. Of these, the cannel coal or parrot coal, as it is called here, yields the best gas; the caking coal or Newcastle coal yields the worst; and the cherry and splint, though very different in their appearance, yield an intermediate gas, the quality of which, whether from cherry or splint coal, is nearly the same.

There are three varieties of cannel coal in the neighbourhood of Glasgow, named from the localities where they occur, Skaterig, Lesmahagow, and Monkland.

The specific gravity of these varieties of coal is as follow:—

Caking coal,	1·280	Mr. Richardson.
Cherry coal,	1·268	do.
Splint coal,	1·307	do.
Skaterig,	1·229	Dr. R. D. Thomson.
Lesmahagow,	1·175	do.
Monkland,	1·189	do.

Besides ashes, these six varieties of coal consist of carbon, hydrogen, azote, and oxygen combined in various proportions according to the coal. I shall here give the composition of each. That of the three first was determined by Mr. Richardson of Newcastle, in the laboratory of Giessen; that of the three last in my laboratory, by my nephew, Dr. R. D. Thomson. The azote is small in quantity—so small, that Mr. Richardson did not succeed in determining its exact quantity; but we found no difficulty in coming to pretty exact conclusions by the process of Will and Varrentrap. As the quantity in all our varieties tried varied from 1·48 to 1·75 per cent. I have supposed that the azote in the three varieties determined by Richardson was the mean of these two quantities, or 1·61 per cent. The following table shows the composition of these coals:—

	Caking Coal.	Cherry Coal.	Splint Coal.	Skaterig * Coal.	Lesmahag. Coal.	Monkland Coal.
Carbon,	87·952	83·025	82·924	76·20	76·25	70·02
Hydrogen,	5·239	5·250	5·491	5·44	6·07	5·56
Azote,	1·610	1·610	1·610	1·75	1·61	1·48
Oxygen,	3·806	8·566	8·847	14·47	12·26	14·86
Ashes,	1·393	1·549	1·128	2·14	2·81	8·08
	100	100	100	100	100	100

It will facilitate our conception of the composition of these different coals, if we exhibit their constitution by empyrical formulas, repre-

* The specimen was marked Knightswood.

senting the atoms of each constituent, the quantity of azote being reckoned 1 atom. We leave out the ashes, because they have nothing to do with the production of the gas, excepting that they materially influence its quantity.

Newcastle, . . .	$C^{127}\ H^{53}\ A^{2}\ O^{4}$
Cherry, ...	$C^{121}\ H^{46}\ A^{2}\ O^{9}$
Splint, ...	$C^{120}\ H^{45}\ A^{2}\ O^{10}$
Skaterig, . . .	$C^{102}\ H^{43}\ A^{2}\ O^{15}$
Lesmahagow, . . .	$C^{110}\ H^{52}\ A^{2}\ O^{14}$
Monkland, . . .	$C^{111}\ H^{53}\ A^{2}\ O^{18}$

It appears from this table, that Newcastle coal contains the most carbon, and cannel coal the least; while cannel coal contains the most oxygen, and Newcastle coal the least. Newcastle coal contains the least hydrogen, and cannel coal the most. Now cannel coal yields the best, and Newcastle coal the worst gas. This need excite no surprise. Carbon not being volatile, it is obvious that if coal contained nothing but carbon, it would yield no gas at all. Coal gas is a mixture of four different gases, most of which are compounds. Two are compounds of carbon and hydrogen, one of carbon and oxygen, and the fourth is pure hydrogen. There is no difficulty in conceiving the formation of the gaseous compounds of carbon and hydrogen; but it is not so easy to explain the formation of carbonic oxide and hydrogen. These two gases are never entirely wanting; at least, I have analysed above forty specimens of coal gas from different kinds of coal, and from different gas works, without ever failing to find them. I think it probable that they make their appearance towards the end of the process of heating the coal. It is well known, that the longer the process of gas making is continued, and the higher the temperature at which the gas is produced, the worse is the gas, and, of course, the more hydrogen it contains. Is it not possible that coal may contain water—that this water can only be extricated at a high temperature—that its oxygen combines with carbon and forms carbonic oxide, while the hydrogen makes its escape in the gaseous state? If this supposition were true, there ought to be a constant ratio between the volume of carbonic oxide and hydrogen in the coal gas. But this not being the case, it is obvious that the supposition cannot be well founded.

A ton of Lesmahagow coal, when distilled at the usual temperature, yields about 10080 cubic feet. One-fifth of the weight of coal is gas, two-fifths coke, and two-fifths tar, water, &c.

The gas contains about one-fifth of the carbon in the raw coal, two-elevenths of the hydrogen, and two-ninths of the oxygen. About one-half of the carbon remains in the state of coke, so that about two-fifths go to the formation of the naphthalin, naphtha, naphthene, naphthol, &c., which are formed during the distillation.

Nine-elevenths of the hydrogen and seven-ninths of the oxygen go to the formation of water and various other compounds. The ammonia formed amounts to about one per cent. of the liquor obtained during the distillation of the coal.

When gas works were first established, the coal was distilled in iron retorts; but it has been found more economical to substitute vessels of stoneware, or rather, indeed, ovens of fire brick made air-tight. These, I believe, have every where superseded the iron retorts.

During the course of last winter, I made thirty-five analyses of gas from different gas works, but most commonly Glasgow gas. The gas which I used was taken from a pipe at some distance from the gas work, because the gas required to be washed and purified before it was examined. After turning the stop-cock, the gas was kindled and allowed to burn for several minutes before I began to collect it. In every case it contained a mixture of common air, which varied in different specimens of gas from 4 per cent. to 28 per cent. The mean quantity was 12½ per cent. The specimen containing 28 per cent. of common air was brought up from Greenock, and though very great care was taken in packing it, it is possible that at least a portion of this air might have made its way into the bottles during the transit. If we omit this specimen, the average quantity of common air in the Greenock gas was 10½ per cent.: the average quantity in the Glasgow gas was 12½ per cent.

I think it most likely that the common air which forms a constant ingredient in all gas from gas works that I have examined, had made its way into the pipes, which it must be very difficult to make air-tight; and when the pressure is removed, common air will undoubtedly enter wherever it can find access. The Greenock gas was collected in an apartment very near the gas works: the Glasgow gas was collected in my laboratory, which may be about a furlong from the gas works. Now, the average quantity in the Greenock gas was 10½, and in the Glasgow 12½.

The highest specific gravity of the Glasgow gas was 0·582, and the lowest 0·463: the average was 0·502.

The quantity of olefiant gas in Glasgow gas varied from 11·77 per cent. to 17·83 per cent.: the mean quantity was 13·52 per cent.

I got gas made at Greenock with as much care as possible, from each of the three varieties of cannel coal found in the neighbourhood of Glasgow, namely, Skaterig, Lesmahagow, and Monkland. The specific gravity of these gases were,

Skaterig, . . .	0·497
Lesmahagow, . . .	0·560
Monkland, . . .	0·622

These are the specific gravities after the air was extracted.

The olefiant gas, per cent., contained in each was as follows:—

Glasgow, . . .	13·52
Skaterig, . . .	14·5
Lesmahagow, . .	17·5
Monkland, . . .	20·

Mr. Ritchie, the manager of the Greenock gas work, who prepared these gases, told me, that he thought rather too much heat had been applied to the Lesmahagow coal, which, in his opinion, would have somewhat deteriorated the Lesmahagow coal gas.

The mean quantity of carburetted hydrogen gas in the Glasgow coal gas was 60·6 per cent.: the smallest quantity was 47·33, and the largest 79·77. The quantity of this gas in the gases from cannel coal were as follows:—

Skaterig, . . .	66·49
Lesmahagow, . . .	59·94
Monkland, . . .	48·77

The goodness of these gases is in the order of naming them. It would appear from this, that the smaller the proportion of carburetted hydrogen the better is the gas. The reason is, that the olefiant gas increases as the carburetted hydrogen diminishes.

The average quantity of carbonic oxide in Glasgow gas was 12 per cent.: the smallest quantity was 6·34 per cent., and the greatest quantity 15 per cent. The quantity of this gas in the three gases from cannel coal was as follows:—

Skaterig, . . .	7·07
Lesmahagow, . .	12·00
Monkland, . . .	11·76

The mean quantity of hydrogen gas in Glasgow gas was 12·44 per cent.: the greatest quantity was 22·85 per cent., and the smallest quantity 2·21 per cent. The quantity in the three gases from cannel coal was as follows:—

Skaterig, . . .	12·29
Lesmahagow, . . .	11·46
Monkland, . . .	17·32

The common method of determining the light emitted by gas during its combustion, is to set fire to a jet of a given height, and issuing from an orifice of a given diameter, and to compare it with the light given out by a wax candle of six in the pound, usually denominated short sixes. An opaque body is placed on a sheet of paper horizontally between the two flames, and it is so placed that the two shadows formed by it are of equal intensity. The distance between this opaque body and the flames is measured, and the light emitted by each is as the square of that distance. Thus, if the distance between the gas flame and the opaque body be two feet, while its distance from the flame of the candle is only one foot, then the light given out by the gas is four times as great as that of the candle.

The light given by the combustion of a jet of Glasgow gas issuing from an orifice of one-thirtieth of an inch in diameter and four inches in height was as follows:—

1. On the north side of the river = 2·68 candles.
2. On the south side of the river = 1·77 do.

This method of measuring the quantity of light appears at first sight very simple; but I found, on trial, that it was attended with so many sources of error, that I was afraid to depend upon it. Fortunately there is another method of much easier execution, which I found much more satisfactory.

The quantity of light given out during the combustion of coal gas is very nearly proportional to its specific gravity. The heavier a gas is, the slower does it issue from an orifice of a given diameter when propelled by a given force. I measured the time which a cubic foot of each gas took to issue from an orifice of one-thirtieth of an inch, when propelled by a force such as to form a jet of flame, when lighted, of four inches in length, and I considered the goodness of the gas as proportional to this time. The result was as follows:—

1. Glasgow gas, North,	.	70′ 18″
2. Ditto, South,	.	60′ 9″
3. Skaterig,	. . .	75′ 0″
4. Lesmahagow,	. .	102′ 40″
5. Monkland,	. . .	100′ 0″

Certainly, in a commercial point of view, the value of the gas (the price per cubic foot being the same in all) is exactly proportional to the time that it takes to burn; because the consumption in a given time depends upon that time.

If, therefore, a thousand cubic feet of gas be charged 8s. on both sides of the river, it is clear that the consumers on the south side pay at the rate of 9s. 4d. per thousand cubic feet, because they consume 7000 cubic feet in the same time that those on the north side consume 6000.

If Glasgow gas, Skaterig gas, and Lesmahagow gas are each charged at 8s. per thousand cubic feet, the price paid by the consumers will be,

1000 feet of	Lesmahagow coal,	8s.
—	Skaterig coal,	9s. 4¼d.
—	Glasgow coal,	11s. 6½d.
—	Ditto, south side river,	13s. 5¾d.

After this paper was read, an interesting discussion took place, during which MR. JOHN HART made the following observations:—

Having heard that Lord Dundonald used gas from coal as a light long before Mr. Murdoch's discovery, and being in Culross Abbey while it was unroofed and in a state of ruin, I naturally began to examine the walls to see if I could discover any trace of the pipes, when Sir Robert Preston's gardener informed me, that he believed no pipes were used, as some of the old people of Culross who saw it, told him that the gas was carried in a vessel from the tar works and burnt in the Abbey.

I afterwards discovered that an intelligent old man, a blacksmith in our neighbourhood, had been long in the employment of his Lordship, and that he had been his assistant in many of his experiments about that period; from him I received the following account:—His Lordship having been in company with some scientific friends, on the following morning he mentioned to his blacksmith that, on the previous night, he had been shown a work* which gave an account of a process for distilling pit coal, and from which a substance like tar might be obtained in considerable quantities. This he wished to try, as he thought it might be made to serve the purposes of common tar; and he then told him to come along with him to the garden, where he pointed out a spot, and gave him instructions to set about the erection of an oven or kiln to try it: the experiment succeeding, nothing more was done until it was secured by a patent. Soon after, nine cylindrical ovens of brick were built in a row, along a bank of earth; these were about 3 feet in width and about 7 feet deep, being hemispherical at top and bottom, each having a moveable cover at top for charging, and a well fitted door at bottom to regulate the combustion: a 7 inch cast iron pipe near the top conveyed the products to the condenser on the top of the bank. The condenser was a flat box of lead, having divisions partly crossing it to detain the vapours of the tar, and very much resembled the coolers used by brewers, from having a rim to retain cold water on its upper surface, with which it was plentifully supplied. The tar was conducted by a pipe into similar cylinders of brick-work on the opposite side of the bank; each of these had a small opening in the top for the escape of the incondensible part of

* This might probably be Dr. Richard Watson's Chemical Essays, published in 1787, in which he details experiments he made on the distillation of pit coal, and also the quantities of coke and tar obtained from various kinds of coal.

the products. To these openings the workmen were in the habit of attaching a cast-iron pipe by means of a lump of soft clay, and lighting the gas at the other end to give them light during the darkness. His Lordship, also, was in the habit of burning the gas in the Abbey as a curiosity; and for this purpose he had a vessel constructed resembling a large tea urn; this he frequently caused to be filled and carried up to the Abbey to light the hall with, especially when he had company with him. On one occasion, after a fresh charge, the workman having applied his light too soon, an explosion took place, which nearly killed some of the men, and tore off the top of the condenser, and one of the workmen's wives passing near it at the time was blown off the bank; fortunately she fell over into her husband's lap (who happened to be sitting below at his breakfast) without receiving any other injury than the fright. However, after this accident the men became very cautious in applying a light to the pipe until the whole of the atmospheric air was displaced. In giving this statement, I do not mean to detract in the smallest degree from the merits of Mr. Murdoch, as it appears this gentleman knew nothing of what was going on at Culross: all I wish to show, was the state of knowledge on this subject in Scotland ten or twelve years prior to Mr. Murdoch's discoveries. As Lord Dundonald's object was the manufacture of tar, his researches would probably be confined to the quantity of tar, and not to the quality of the gas; and as his gas from the tar kilns must have been very inferior, being from common coal and also partly mixed with the air after combustion in the kilns, the light must have been inferior to candles; but even although he had observed the high illuminating power of gas from cannel coal, the high price of cast-iron pipes, and the little use they were put to, especially in Scotland, at that period, must have rendered such an idea, if it had ever occurred to him, or even to Dr. Clayton, as a thing perfectly impracticable. It required a more extensive knowledge and experience in engineering than any of these gentlemen were possessed of, to entertain for a moment the practicability of such a scheme; even Mr. Murdoch and his friends at Soho seem to have had their doubts about the possibility of raising funds sufficient for such a gigantic undertaking as the lighting of a city, if we may judge from the little interest they took in it even after lighting up the cotton factory of Messrs. Lee & Co. of Manchester.

Shortly after fitting up the little gas apparatus described in Robertson Buchanan's Treatise on Heat, as we could not procure cannel coal at that time in Glasgow, we were obliged to make our gas from common coal, the flame from which being very grey, I thought it might be possible to improve it, or to make the gas take up an additional dose of carbon by making it pass over charcoal of wood at a strong red heat previous to its entering the condenser, and that I might also produce a greater quantity of gas by more effectually decomposing the tar. For this purpose I procured a one-and-a-half inch cast-iron pipe, and having charged it with charcoal, I passed it through the furnace below the retort, and joined one end with the pipe from the retort, and the other end to the pipe leading to the condenser, the fire was then applied, and the retort charged as usual. After the gas-holder had risen about a foot, we observed the pipe leading to the condenser (which was of lead) becoming very hot; it soon after gave way and fell to pieces, and the whole of the gas escaped into the air, but it had no longer the yellow silky appearance of gas issuing from a retort, it had become a white vapour, and had also lost the smell. As we could not collect any more of the gas, we withdrew the fire, and allowed the whole to cool down. When I took out the charcoal to examine it, in place of its being acted upon by the gas as I supposed, I found it covered all over with a beautiful smooth shining black coat of carbon which had been deposited upon it. This was extremely brittle, and started off like scales of iodine when pressed upon by the nails. As the gas was mixed with part of a former charge, we could not ascertain its quality, but it certainly did not seem at all improved; indeed, the gas seemed rather to have parted with a portion of its carbon, (by passing through the red hot charcoal,) than to have acquired an additional dose. On this account I did not prosecute the experiment farther. However, this deposition of carbon in the solid form upon the charcoal led me to examine more minutely the appearances of similar shining depositions upon pieces of common coke, and also the deposits of carbon that were formed both within and below the retorts of the Glasgow gas work. The change, too, that was produced upon the flame of a piece of coal in an open fire arrested my attention also. I observed that when it passes up through a mass of glowing cinders, it loses its brightness, and becomes of a dusky yellowish red colour like common hydrogen, just as if the carbon had been abstracted from the hydrogen in its passage through the cinders; and, therefore, when I saw the report drawn up by Dr. Henry, of the analysis of the gas obtained by him during different periods of the charge from the same retort, this deterioration of the gas in the latter period of the charge appeared to me to proceed rather from the deposition of the carbon held in solution by the gas in coming into contact with the new formed coke in the exterior part of the charge, than from an inferior gas being given off from the coal in the centre of the retort, any more than from that part of the coal which was in contact with the retort itself. And, therefore, to obtain gas of nearly as uniform a quality as possible from the whole of the charge, a change ought to be made upon the present form of retorts, so as not only to apply the coal in a thin layer to the surface of the retort, (as had already been pointed out by Mr. Maben of Perth,) but also to protect the gas from the action of the incandescent carbon when formed.

15*th November*, 1843,—*The* President *in the Chair.*

Messrs. John Turnbull, Thomas Edington, John Fisher, Rev. Isaac Hitchin, Rev. Lewis Page Mercier, were admitted members of the Society.

Dr. Balfour presented to the Society a paper by Dr. Maclagan, on the Beeberu bark, for which the thanks of the Society were voted.

Mr. James Thomson called the attention of the Society to the propriety of memorialising Government to resume and prosecute with vigour the ordnance survey of Scotland. A committee was appointed to draw up a memorial.

The treasurer exhibited his audited accounts for last year, showing at the credit of the Society £60 in bank, and £5 11s. 8½d. in treasurer's hands. The librarian also presented his accounts audited, exhibiting the receipt of £105 14s. 5d., and an expenditure of £70 3s. 10d., leaving a balance of £35 10s. 7d. in librarian's hands.

The Society then proceeded to the forty-second annual election of Office-Bearers, when the following were chosen for the session 1843-44:

Office-Bearers.

President—Professor Thomas Thomson, M.D., F.R.S. L. & E., F.L.S., &c.

Vice-President, ...Walter Crum. | Secretary,.........Alexander Hastie.
Treasurer, ...Andrew Liddell. | Librarian, ...Thomas Dawson.

Council.

A. Anderson, M.D.	Professor Gordon.	John Stenhouse, Ph.D.
J. H. Balfour, M.D.	William Gourlie.	James Thomson.
A. Buchanan, M.D.	J. J. Griffin.	R. D. Thomson, M.D.
J. Findlay, M.D.	Alex. Harvey.	Alex. Watt, LL.D.

Library Committee.

Walter Crum.	John Findlay, M.D.	J. H. Balfour, M.D.
Alex. Hastie.	J. J. Griffin.	Professor Gordon.
James Thomson, C.E.	R. D. Thomson, M.D.	Alex. Watt, LL.D.

Chairman, Thomas Dawson.

Publishing Committee.

The President and Vice-President—The Secretaries of the Sections.
Chairman, R. D. Thomson, M.D.

It was suggested by Dr. R. D. Thomson and agreed to, that a Botanical Section should be added to the other branches of the Society, —that the office-bearers of each section should in future be a chairman and secretary, so as to enable each section optionally to hold separate meetings for the discussion of subjects connected with its own science, each secretary preparing the minutes of the proceedings of his section, and reading them at the next general meeting of the Society.

Office-Bearers of Sections.

Section A.—Agriculture, Statistics, and Domestic Economy.
Chairman, William Murray—Secretary, Alex. Watt, LL.D.

Section B.—Chemistry, Mineralogy, and Geology.
Chairman, John Stenhouse, Ph. D.—Secretary. R. D. Thomson, M.D.

Section C.—Physics, including Mechanics and Engineering.
Chairman, Professor Gordon—Secretary, James Buchanan.

Section D.—Physiology and Natural History.
Chairman, Professor Andw. Buchanan, M.D.—Secretary, J. Findlay, M.D.

Section E.—Botany.
Chairman, Professor J. H. Balfour, M.D.
Vice-Chairman, Walter G. Blackie, Ph.D.—Secretary, William Keddie.
Curator of Herbarium, Robert Balloch.

29*th November*, 1843,—*The* President *in the Chair.*

The following members were elected:—Messrs. Adam Patterson, George Jasper Lyon, Robert Balloch, James Johnston, James Bell, Andrew Bain, Professor Allan Maconochie.

Mr. Crum read a report from the Committee on Arrears. Mr James Thomson read a draft of the Memorial to Government respecting the survey of Scotland, which was approved, and ordered to be transmitted forthwith. The following paper was then read:—

XLII.—*Hints for the Formation of a Friendly Society for the Professional and Mercantile Classes.* By William Spens, Esq.

The extent to which at present allowances are provided under Friendly Societies is not, so far as I am aware, so great as to afford any considerable relief, generally speaking, to those who are drawing incomes from professional or mercantile pursuits—at least not in a degree corresponding to the immense benefits such societies, if properly constituted, confer on the classes of the community for which, no doubt, they were originally intended. In the present communication it is proposed to submit briefly the grounds which appear to exist for an extension of these advantages to a numerous class among professional and mercantile persons, and the mode in which this could be efficiently accomplished.

One of the objects, but a subordinate one, among present Friendly Societies, is that of securing a sum on the death of the members, and this is certainly an object of great importance, but I am not likely to say that there is any deficiency of provision for all classes for this contingency. Another provision which is made by Friendly Societies is for old age, and this also may, to a larger extent, be secured from insurance offices, but it is not believed that their business in this branch is of much consequence to themselves. For neither of these provisions, however, would I propose its institution, nor even if sickness were only of a temporary character. Such will not affect us materially; but I think it must be a general feeling among persons whose income is derived from a salary, that permanent sickness would leave their families almost totally unprovided for. They can provide for them while health remains—they can provide for them in the event of death; but supposing they were struck with palsy or permanent blindness, their families might be rendered destitute. No doubt it will be said, that the chance of such calamities is comparatively small, and this is fortunately true; but it is no reason why we should not guard against the consequences of such a dire disaster—it is rather cause for thankfulness that the sacrifice for the purpose is small. If rarity were to determine us, we should cease to insure our dwelling-houses against fire, especially when, in consequence of the duty, we pay for three times what the risk is accounted. The calamity for which I wish provision to be made is much more serious; and there would be no need of paying out of the society more than the risk requires—indeed, I wish to persuade you, that the object in view may be secured in combination with a deferred annuity, to commence at an advanced age, by payments not higher than some insurance offices would charge for the latter alone. The object may thus, in some sense, be secured for nothing.

I might have preferred leaving the deferred annuity to be sought at life insurance offices, or at least to have made a separate table for it in the proposed society; but it must be of great importance, as a set off for a provision which, if commenced much earlier, is not likely to continue beyond 70, to have one which is then only to commence: thus, with the other guards which may be interposed, placing a check upon parties seeking admission with any unfair views as regards the sickness claim. The provision, however, for an allowance at an advanced age, in whatever state of health, is obviously intimately in accordance with the object of the proposed society. It is thus intended certainly to provide for superannuation, and, no doubt, those who reach 70 in good health, are not incapacitated from old age; but still to many, if not to all, more rest is then better, and it is desirable, if possible, to prevent any from being deterred by pecuniary considerations from retiring from active business, if warned by the advancement of years of the propriety of such relief, totally or partially.

In regard to the contributions, I will not pretend to offer very precise calculations, but I will promise simplicity, and I think you will be satisfied as to adequacy. The following are the annual contributions which would be required by the tables of the Highland Society and those of Mr. Ansell, for an allowance of £2 a week, or £104 a year in sickness, both temporary and permanent, up to 70, interest being accumulated at 4 per cent:—

Age.	Highland Society.	Ansell.
20,	. . . . . .	£2 8 10
25,	£2 2 10	2 14 10
30,	2 9 6	3 2 7
35,	2 18 4	3 12 11
40,	3 10 8	4 7 7
45,	4 7 8	5 5 9
50,	. . . . . .	6 5 4

According to the Highland Society's Report, three-tenths of sickness are estimated as permanent, and I conceive that one-third may be taken as the amount with every probability of being within the mark. It will be observed, however, that in the proposed rates an addition to this is made, and in the regulations of the society, other securities are proposed.

Supposing, then, the permanent sickness to be one-third, of course the annual payments required for £2 a week or £104 per annum, up to 70, would be just one-third of the sums in the preceding table. These are subjoined with the annual contributions for a similar deferred annuity according to the same tables, to commence at 70, and the sum of the rates for the two provisions; and along side are placed rates charged by two insurance offices for a deferred annuity of £100, commencing at 70, and the same rates according to the Carlisle 3 per cent. table. Next are placed the rates I would consider adequate for £100 a year during permanent sickness to 70, and the like annuity from that age, payable in whatever state of health, assuming 4 per cent. interest and no expense; and lastly are placed the rates I would propose for the intended society.

These rates I would consider ample; at the same time I do not think that the Society should commence until there were at least fifty subscribers, and that it should at first limit itself to allowances of £100 a-year, extending the risks beyond that amount when fifty members were entered for such extended risk. A great security is obviously attained, by combining the provision for deferred annuity with that for sickness, and, as an additional one, I would suggest that no allowance should be made to a member until he had been enrolled five years. Of course there would also be medical examination of the candidate, and admission should be by ballot, after recommendation by directors; but it may be noticed, that parties might, in reference to the provisions of the Society, be admitted, who would not be eligible for admission into an ordinary life insurance office. I would suggest that the allowances of the Society should be according to the rates below, for £100, £150, £200, £250, and £300 a-year. I may add, that I think there ought to be periodical investigations, when a diminution of the allowances may be made in the event of any possible shortcoming: and in the more probable event of a surplus, I would propose it should be applied to hastening the commencement of the deferred annuity.

TABLE OF RATES REFERRED TO.

Age.	Annual Rates for £2 a week, or £104 yearly in Permanent Sickness, (*assumed at one-third of all*) to 70, and for £104 Deferred Annuity after 70,—Interest 4 per Cent.						Deferred Annuity of £100 from 70, according to the Rates of two Life Insurance Offices, and also according to Carlisle 3 per Cent. Tables.			Rates considered adequate for £100 yearly in Permanent Sickness to 70, and for Deferred Annuity from 70, assuming Interest at 4 per Cent. and no expense.			Proposed Rates for £100 a year.
	Highland Society.			Ansell.									
	In P. S. to 70.	D. A. from 70.	Sum.	Sum.	In P. S. to 70.	D. A. from 70.	One Life Office.	Another Life Office.	Carlisle 3 per Cent.	D. A. from 70, Carlisle 4 per Cent.	In P. S. to 70.	Sum.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
20	0 0 0	0 0 0	0 0 0	2 9 10	0 16 4	1 13 6	0 0 0	2 18 4	2 18 4	1 19 4	0 17 6	2 16 10	3 0 0
25	0 14 3	2 5 1	2 19 4	3 3 2	0 18 3	2 4 11	3 19 2	3 15 0	3 14 0	2 11 10	1 0 0	3 11 10	4 0 0
30	0 16 6	3 0 8	3 17 2	4 1 9	1 0 10	3 0 11	5 3 4	5 0 0	4 15 4	3 9 3	1 3 11	4 13 2	5 2 6
35	0 19 5	4 3 3	5 2 8	5 8 9	1 4 4	4 4 5	6 16 8	7 1 8	6 4 11	4 14 2	1 6 3	6 0 5	6 12 6
40	1 3 7	5 17 1	7 0 8	7 9 1	1 8 10	6 0 3	9 5 0	9 3 4	8 7 8	6 11 11	1 10 5	8 2 4	9 0 0
45	1 9 3	8 9 5	9 18 8	10 11 9	1 14 11	8 16 10	12 16 8	12 18 4	11 12 1	9 7 6	1 15 10	11 3 4	12 5 0
50	0 0 0	0 0 0	0 0 0	15 16 1	2 3 2	13 12 11	0 0 0	18 15 0	16 15 3	13 19 11	2 3 11	16 3 10	18 0 0

I am well aware that there is very great difficulty in defining permanent sickness, and that many will say that the scheme is impracticable on this account. But if it cannot be otherwise satisfactorily ascertained, it may, by appointing a tribunal, whose decision upon a case is to be decisive, and upon the whole I think that this would be the best arrangement, and would effectually prevent any questions. The cases would be very rare, but perhaps when they did occur, the judges might consist of the directors for the time, with a medical gentleman appointed by each director, or there might be a permanent appointment, besides an ordinary medical officer, of a number of medical gentlemen to be united with the directors in deliberating on such cases as might occur. Dependence on the honour and judgment of such a board would, I think, be preferable to an attempt at special definition, which might lead to litigation.

The widows' scheme of the ministers and professors of Scotland, confers most important advantages on their families after their death. Its early formation, and on principles which have, I believe, been found practically most correct, is a great honour to the body, but I am surprised that no such scheme as is here suggested, has been brought within their reach. The service to the public, and the comfort to themselves of such an institution, would be indeed very great. At present, if a case of permanent sickness occurs, a usual proceeding is, that a helper be appointed, who receives a portion of the emoluments, and a similar arrangement is made where a party is disabled by infirmity of years. The sacrifice of income these arrangements make to both parties, often prevents them being entered into so early as they should be, narrows the field for choice of a successor, and, by materially affecting the status of the latter, tends to impair his usefulness. These disadvantages are indeed felt and acknowledged, and can only be satisfactorily prevented, by making it compulsory for every one, on their appointment, to join such a society as is here proposed.

Many other instances of the applicability of a Professional and Mercantile Friendly Society, such as we have suggested, might be given. I am glad to see the benefits of insurance spreading usefully in different directions, and I doubt not that, sooner or later, the extension—in some sense modification—of the principles of friendly societies here proposed, will be introduced with advantage to the community. "Wherever," says the Report of the Committee of the House of Commons on Friendly Societies in 1827, "there is a contingency, the cheapest way of providing against it is by uniting with others, so that each man may subject himself to a small deprivation, in order that no man may be subjected to a great loss. He upon whom the contingency does not fall, does not get his money back again, nor does he get for it any visible or tangible benefit, but he obtains security against ruin, and consequent peace of mind. He upon whom the contingency does fall, gets all that those whom fortune has exempted from it have lost in hard money, and is thus enabled to sustain an event which would otherwise overwhelm him." This well defines the principle of all insurance. I may be somewhat of an enthusiastic admirer of the system, but if one will only consider what the state of society would be without any such protection as it affords, he will, I think, feel how much we are indebted to the truth-investigating labours of the statist, for so great an ally of prudence, so useful a guardian of industry.

13*th December*, 1843,—*The* President *in the Chair.*

The following were elected Members of the Society:—Messrs. Jas. Church, David Thomson, B.A., Charles Griffin, Walter Nielson, Wm. Dunn, James Bogle, and Charles Maxwell Graham.

According to previous arrangement, Mr. Crum moved that a Botanical Section should be added to the Society, and Mr. Gourlie was requested to convene the Members who intended to join it, for the purpose of choosing their office-bearers, and making other necessary arrangements.

Mr. James Thomson, C.E., described two iron lattice bridges, illustrated with models, which have been erected, one in Scotland, the other in Ireland. Mr. Stenhouse exhibited a Davy lamp, constructed with mica plates, which appeared well adapted for the purposes of the miner.

The following paper was then read:—

XLIII.—*On Parietin, a Yellow Colouring Matter, and on the Inorganic Food of Lichens.* By Robert D. Thomson, M.D.

The objects of the present paper are, 1st, to endeavour to prove that, contrary to the usually received opinion, the class of plants termed lichens require inorganic matter as part of their food, which they must derive from the localities upon which they are fixed; and 2d, to describe the yellow colouring matter obtained from the yellow wall lichen, and to detail its properties, composition, and application as a test for alkalies.

Although chemists are acquainted with several yellow colouring matters, few of them have been separated in a pure state, and analysed. This arises from the difficulty of procuring such substances in the same state as that in which they existed in the plant from which they are extracted—depending principally on the facility with which they unite with oxygen, and on their consequent conversion into a body of inferior beauty, and of an uncrystallized structure. The yellow colouring matters which have hitherto been analysed, are derived from various parts of phenogamous plants, principally the roots and flowers. The subject of the present paper is procured from a totally different tribe—the lichens—but one to which we are indebted for some important dyes. The Greeks gave the name λειχην to a disease of the skin, and likewise to certain plants possessing the power of healing these cutaneous eruptions. Dioscorides * tells us that the lichen, which is familiarly known from its growing on stones, and attaching itself to the rough parts of rocks, like a moss, was called by some persons *bryon*, and was useful in the cure of sanguineous fluxes and inflammations. Pliny likewise uses the term lichen; but from his describing it as growing on rocks, with one leaf from a broad root, and with one small stem, it is obvious he refers to a species of hepatica.† Galen likewise enumerates lichens among the instruments of cure, in the treatment of impetiginous or cutaneous diseases. Modern botanists, up to a comparatively recent period, appear to have overlooked this class of plants, if we may draw this conclusion from the catalogue of English plants, by John Ray, the second edition of which was published in 1677. In this work, the celebrated author describes, under the title of lichen, eight species of plants, only three of which, however, can be reckoned true lichens, the remainder being hepaticæ and algæ. In Hooker's Flora, published in 1833, there are enumerated and described thirty genera and 420 species of lichens. It is well known that many of these are capable of supplying powerful dyes.

The lichen from which the colouring matter to be described is derived, is of very frequent occurrence on walls and trees. It is the *Parmelia parietina* (yellow wall parmelia), described by Hooker as possessing a rounded bright yellow frond, with lobes radiating, marginal, appressed, rounded, crenate, crisped, and granulated in the centre. The *repositories*, or apothecia, are deep orange, concave, with an entire border. The bright yellow colour of the lichen is a sufficient indication of the presence of a colouring matter, but the real intensity of the colour could scarcely be anticipated merely by an inspection of the plant.

FOOD OF LICHENS.

The most luxuriant samples of the parmelia, grow in the neighbourhood of the sea, from what cause, unless it be the moistness of the air, it is not easy to determine. Botanists consider that this race of plants derive no nourishment from the rocks upon which they grow, although the circumstance of many of them containing oxalate of lime would appear to afford a demonstration of their being enabled to suck up inorganic substances in the same manner as other plants. Viewed in this light, the moistening and decomposing effect of a humid atmosphere on the rocks on the sea coast, may explain the

* Mat. Med. B. IV., Cap. 48. † Nat. Hist., xxvii. c. 4.

almost herbaceous appearance of some of the lichens which may be observed in such situations. The subject, however, of the nutrition of lichens is in its infancy, and will require a searching investigation.

It has been already stated that, according to the opinion of botanists (Hooker's English Flora), lichens derive no nourishment from the rocks, stones, or trees on which they grow. The roots or fibres with which they are often supplied, it is conceived, are only useful in fixing the plant to its place of growth, its nutriment being derived from the air. One of the most common of our lichens, the *Peltidea canina*, possesses fibres on its under surface so closely resembling those of shrubs, that one would be inclined to attribute to them similar functions. The circumstance, as stated in chemical works, of the absence of any considerable quantity of inorganic matter in the composition of lichens, would appear to lend countenance to the view, that gases constitute the only food of lichens. But the fact of oxalate of lime having been obtained from many lichens, seemed to call in question the validity of the conclusion. The detection, also, of small portions of bitartrate of potash and phosphate of lime in some lichens, added still further evidence against the opinion of botanists. So far as I am aware, no other substance of an inorganic nature has been hitherto detected in lichens, except in such minute proportion that it might have been derived perhaps from extraneous sources. I was not therefore prepared to expect the remarkable results which the analysis of the yellow parmelia afforded. In one experiment, 50 grains, obtained from mica slate rocks at Dunoon, on the west coast of Scotland, when ignited, yielded 3·4 grains of inorganic matter; and in another experiment, 40 grains, to which, as in the preceding trial, no earthy matter was attached, afforded, by burning, a residue of 2·7 grains. In a third experiment, 7 grains of the carefully selected upper parts of fronds, which had never been in contact with rock, and therefore were free from the suspicion of having extraneous particles mixed with them, after washing, as in the previous trials, yielded, by incineration, 0·47 grains of a skeleton, answering to the form of the lichen, and consisting of silica and phosphates, &c. These three experiments, therefore, give a per centage respectively of ashes, amounting to 6·8, 6·75, and 6·71.* In all these trials the colouring matter was volatilized before the lichen caught fire. Another specimen, very carefully washed, and consisting of the upper parts of fronds, yielded 5 per cent. of ash, in which phosphate of alumina formed a prominent ingredient. In proof of the fact that the ash is in no degree connected with the rock, a specimen of *Parmelia omphalodes*, taken from the stem of an ash tree, ten feet from the ground, was ignited, and found to yield 7 per cent. of ash, consisting of silica, phosphates of lime, iron, and alumina. The *Cladonia pixidata*, taken from a wall, and free

* These determinations were made in conjunction with Mr. James Murdoch.

from all extraneous substances, yielded 6 per cent. of ashes, consisting of similar ingredients. Hence it would appear, that this species of plants contain no inconsiderable amount of substances calculated to serve as vegetable manure. The ash possessed the form of the lichen, and a slight iron tint; it effervesced slightly on the addition of an acid. In one instance, some carbonate of lime was present. On digesting the ash in water, a minute portion was dissolved. This solution, on the addition of chloride of barium, gave a white precipitate, part of which was insoluble in nitric acid. On throwing the sulphate of barytes on a filter, and adding caustic ammonia to the filtered liquid, a flocky precipitate—phosphate of barytes—fell. The addition of an alcoholic solution of bichloride of platinum, gave no indication of the presence of potash. Nitrate of silver gave a flocky precipitate, insoluble in nitric acid. The soluble salts, therefore, appear to be sulphate and phosphate of soda and common salt. The portion of the residue insoluble in water, became nearly white when boiled with dilute muriatic acid, and left a gritty powder, which, affording a nearly colourless glass with carbonate of soda before the blowpipe, was obviously silica, with slight impurity. The muriatic acid solution gave a copious reddish precipitate, with caustic ammonia. This precipitate was partly soluble in caustic soda, and consisted of phosphates of iron, alumina, and lime. The latter precipitates being tested with lead, yielded a precipitate of phosphate of lead, soluble in nitric acid. The results of the analysis of two specimens of ashes were as follows:—

	I.	II.
Silica, ...	68·46	64·62
Soluble salts, sulphate, phosphate, and muriate of soda, ...	0·75	—
Peroxide of iron, and phosphates of iron and lime, ...	22·04	34·55
Phosphate of alumina, ...	—	0·83
Carbonate of lime, ...	8·75	—
	100·	100·00*

From these facts it is evident that this lichen requires the same inorganic constituents for food as other plants, with this difference, that the amount of inorganic substances present in its composition is greater than in higher orders of plants, but in a proportion tending towards that existing in the sea weeds; another character, therefore, in addition to the general external features, indicating an alliance between the algæ and lichens.

* Mr. David Murdoch assisted me in the first analysis, and Mr. James Murdoch in the second.

To ascertain if the great abundance of inorganic matter was peculiar to this species, the *Parmelia omphalodes* was incinerated, the specimen being taken from a portion collected by a Highlander on the borders of Loch Venachar, where it is extensively used, as well as generally in the Highlands, with an alum mordant, to impart a fine purple to woollen cloths. Its habitat had been a rock, and portions were selected free from any appearance of suspended earthy particles among their roots; 200 grains gave a residue of 7·8 grains, consisting of substances similar to those already enumerated in the analysis of the yellow parmelia. Part of these, however, may have been foreign. When we compare the amount of these inorganic constituents with those found in trees, the balance appears in favour of the lichens, as shown by the analyses of the ashes of genuine specimens of lima, sapan, and logwoods. The results are, in 1000 parts—

	Lima Wood.	Sapan Wood.	Logwood.
Organic matter, . .	971·255	987·083	971·400
Silica and sand, . .	1·800	—	7·800
Common salt, . . .	—	0·517	0·129
Alkaline phosphates and sulphate, . . .	2·000	0·850	1·371
Phosphate of lime, . .	0·725	—	1·021
Carbonate of lime, . .	24·140	11·650	18·279
	1000·	1000·	1000·000 *

Both of these classes of plants alluded to, however, appear but insignificantly supplied with inorganic matter, when contrasted with some of the gigantic sea-weeds from Cape Horn. 490 grains of one of these enormous inhabitants of the deep, supplied me by Dr. Joseph Hooker, yielded, by incineration, 116·7 of ashes, equivalent to a per centage of 23·8.

The introduction of inorganic matter into the substance of trees and lichens, can only be effected by the inferior extremity and surface of those portions which are in contact with the source of this peculiar pabulum of vegetable life; while it would appear that the connexion which we always find to exist between sea-weeds and some fixed rocky position, even in the case of these immense inhabitants of the southern seas, according to some physiologists, only serves the purpose of retaining them stationary in one locality, their food being derived from the fluid in which they are immersed. But whether this be true or not, it is certain that the waters of the ocean are capable of affording nearly, if not all, the inorganic ingredients with which these plants are supplied. Trees and lichens have no such atmosphere, rich in salts, from

* In these analyses I was assisted by Mr. John Aitken.

which they can derive their food. They must be indebted for the inorganic matter which they contain to the soil upon which they grow. Hence, since lichens do certainly contain inorganic matter of various kinds, as appears by the facts detailed in this paper, the inevitable conclusion is forced upon us, that these species of plants are not only nourished by the atmosphere, to which botanists have hitherto appeared to restrict their sources of food, but that they are also capable of extracting inorganic matter from the rocks and trees over whose surfaces they are so largely distributed as humble tenants.

PREPARATION OF PARIETIN.

When the yellow *Parmelia* is digested in cold alcohol, of ·840, a yellow liquid is obtained, obviously from the solution of the yellow colouring matter of the lichen. When boiled gently the liquid becomes deeper coloured, and when a sufficient quantity of alcohol is employed, and the liquor is allowed to evaporate spontaneously, the colouring matter is deposited on the sides of the vessel, in the form of fine needles, sometimes a quarter of an inch in length. The specimens of lichen from which the best crystals of this description were obtained, were from the neighbourhood of Glasgow, and were rather dry, as if they had grown upon a dry wall, little exposed to moisture.

In order to procure the colouring matter of the P. parietina, it is proper to dry the plant at a moderate temperature. This is particularly to be attended to with the sea specimens, which are succulent when compared with the plants from other localities. By this precaution, the alcohol will more effectually extract the colouring matter, without violent or long-continued boiling. We should probably succeed in obtaining the purest product, by removing as much as possible of the water from the lichen, by drying in a stove, and then digesting in cold alcohol. The quantity of the lichen at my disposal has not hitherto been sufficient to enable me to attempt to extract the colouring matter in this manner, but I intend to do so on the first opportunity. I have stated that I have succeeded in obtaining the colouring matter, or *Parietin*, as I propose to term it, in the form of needles, but generally it falls in the shape of brilliant yellow scales, as the alcoholic solution cools. The mode in which I have extracted it was by gently boiling for a few minutes the lichen in contact with the alcohol, then filtering and adding fresh alcohol until the colour appeared to be extracted. The solution has scarcely passed through the filter, before it begins to deposit the shiny scales of *parietin.* If we attempt to purify these by re-dissolving them in alcohol, we shall find that only a portion is dissolved, and the deposit from the alcoholic solution, instead of presenting the lustre of the substance as at first obtained, assumes the aspect of a brownish yellow powder.

COMPOSITION OF PARIETIN.

The product of the second solution in alcohol, when dried at 212°, and burned with oxide of copper, afforded the following result:—

3·16 grains gave 7·376 carbonic acid.
1·410 water.

This corresponds with

		Expt.	Atoms.	Calcula.	Atoms.	Calcula.
Carbon, .	2·0116	63·65	40	63.82	40	62·51
Hydrogen,	0·1566	4·95	16	4·25	16	4·16
Oxygen, .	0·9918	31·40	15	31·93	16	33·33
	3·1600	100·		100·		100·

As it appeared from the preceding result that the parietin was altered in its character by attempting to re-dissolve it in alcohol; the parietin, after being dissolved in alcohol from the lichen, was, after the filtration of the fluid, allowed to deposit by cooling. It was then thrown on a filter, and dried on a tile, and then digested in hot alcohol, to remove any fatty or resinous matter with which it might be contaminated. The same object may be attained by digestion in ether. The *parietin* was then dried at 212°, and analysed.

2·96 grains afforded, when burned with black oxide of copper,

7·15 grains carbonic acid.
1·294 " water.

This is equivalent to

		Expt.
Carbon, ...	1·9500	65·87
Hydrogen, ...	0·1437	4·85
Oxygen, ...	0·8663	29·28
	2·9600	100·

and agrees with the following calculation:—

		Calculation.	Expt.
Carbon, . .	·75 × 9 = 6·75	65·85	65·87
Hydrogen, . .	·125 × 4 = ·5	4·87	4·85
Oxygen, . .	1· × 3 = 3·0	29·28	29·28
	10·25	100·	100·

The formula, therefore, will be according to this view,

$$C_9\, H_4\, O_3$$

or we may, as in the preceding case, consider it as an oxide of an oil, and the composition when calculated would be,

	Atoms.	
Carbon, ...	40	65·21
Hydrogen, ...	16	4·34
Oxygen, ...	14	30·45

and the formula

$$C_{40}\ H_{16}\ O_{14}$$

exhibiting a stage in the oxidation of an oil similar to what we meet with in the gradual production of resins from oils of the turpentine type. In some respects the colouring matter under discussion resembles a resin, and especially in its appearance when precipitated from its solution in alkalies by an acid. If we then consider parietin as a resin, deriving its origin from an oil of the turpentine type, the preceding analyses may be classed as follows:—

Oil of parietin, ...	$C_{40}\ H_{16}$
Parietin, ...	$C_{40}\ H_{16}\ O_{14}$
Oxide of parietin, ...	$C_{40}\ H_{16}\ O_{16}$

The effect of re-agents upon parietin is striking. A very minute portion of the substance will impart its yellow colour to a large quantity of alcohol, and this solution is sensibly acted on by re-agents. When to such a solution a drop or two of nitric, or muriatic or sulphuric acids are added, the yellow colour imparted to it by the *parietin* becomes much heightened, and even a very small proportion (much more minute than that mentioned) will effect a sensible change. When the solution is strong, the addition of acid produces a yellow precipitate. When caustic ammonia, in the smallest quantity, is dropped into, or applied by means of a rod, to a solution of parietin, the yellow colour immediately becomes a rich red, inclining to purple. The same result is obtained with caustic potash, caustic barytes, carbonate of soda, caustic lime, &c.

PARIETIN AS A TEST OF ALKALIES.

The extreme delicacy of parietin in detecting alkalies, suggests its utility in the laboratory. An alcoholic solution may be kept for use, as the addition of a drop or two of the solution to a considerable quantity of an alkaline liquor, will be immediately followed by a change to red; or the process may be reversed, by placing a few drops of the alcoholic solution in a test-glass, and adding to it a drop or two of the alkaline liquor. The alcoholic solution may be prepared simply by digesting the lichen in cold alcohol, of sp. gr. ·840, as I have found that a small portion of lichen will impart a colour to a large quantity of alcohol, sufficiently intense to serve as a very delicate test for alkalies. Observing the strong colour that the alcoholic solution imparted to the filtering paper which was used to purify the solution when first prepared, I cut these into test papers, and found that, when properly impregnated with the solution, they were little, if at all inferior to turmeric paper, in their delicate detection of ammonia. Test paper may be prepared extemporaneously from the alcoholic solution, when it is wished to detect ammonia, by dipping a piece of paper into the alcoholic solution, and then applying it in its wet state to the ammoniacal vapour. The yellow colour is immediately transformed into a reddish purple, but more distinct than the colour that becomes apparent in turmeric paper of old preparation, under similar circumstances, which is a dirty brown. One of the principal recommendations of the liquid test already noticed, is the circumstance of its being capable of preservation without undergoing deterioration, while the test papers which have been frequently recommended, although possessing most delicate testing powers when freshly prepared, gradually lose their value by preservation. I believe this to be the explanation of the failure in this country of some continental test papers, which have been recently recommended. It would therefore appear, that the best test paper being that which is of fresh preparation, the most convenient source for its production is that from which it can be most rapidly procured in an efficient state. The observations which have been made upon parietin, in reference to its colouring powers, tend to show that it may be employed with advantage for the most delicate purposes to which turmeric is applied. Parietin, however, is not acted on by acids; the natural yellow colour merely becomes brighter, while turmeric, which contains a blue and yellowing colouring principle, has the former reddened by acids, and the latter converted to a brown by alkalies. Moistened yellow *parietin* paper, on the other hand, becomes red or purple when freshly prepared, and reddish brown, if long prepared, by coming in contact with ammonia and other alkalies. The other reactions of parietin are simple. The alcoholic solution is precipitated yellow by nitrate of silver and acetate of lead, and other metallic salts. A solution of permuriate of iron renders the colour much darker. The precipitates with silver and lead have not been analysed, from the minute quantity of parietin at my disposal.

The yellow colour of the *Parmelia parietina* early attracted the attention of those persons interested in dyes. It was accurately described by Hoffmann, Amoreux, and Willemet, in 1786.* The latter informs us, that the Swedes in the province of Oeland obtained by means of this lichen and alum a yellow dye for woollen stuffs, and that a flesh tint was also procured from it, fitted for linen and paper; that goats eat this lichen, and that Haller recommended it as a powerful tonic in diarrhœa. He adds, that he had himself used it in his practice as a tisan, and had found it to prove beneficial in that form of the

* Memoires couronnés en l'anneé, 1786, par l'Academie des Sciences, Belles Lettres, et Arts, de Lyon, sur l'utilité des lichens, dans la Medicine et dans les Arts. 8vo, 1787.

disease which occurs in autumn. Hoffmann states, that in Norway, when boiled with milk, it is used as a remedy in jaundice. This idea may have perhaps originated from the correspondence in colour of the disease and cure, upon the principle so much in vogue at present, "*similia similibus curantur.*" Hoffmann affirms that he never could obtain a yellow colour from this lichen, but that with wine vinegar he obtained an olive-green or fawn colour; and with true wine vinegar (*aceto vini vero*) and copperas, a flesh or apricot shade. Of these colours he has appended to his essay specimens, together with forty-nine others, obtained from various species of lichens. Dr. John P. Westring of Nordkoping, in Sweden, who prosecuted an extensive inquiry into the colouring matter of lichens, describes the *Lichen parietinus* (Wagglaf) as affording, with wool, by infusion for fourteen days, and then boiling for half an hour, a fawn colour; by longer boiling a yellow was produced, and this mixture became, by simple infusion and extraction, similar to the red wool of Florence. With common salt and nitre boiled for an hour, a beautiful straw colour was elicited. Upon silk it gave similar colours, differing in their shade from red to yellow, according to the methods employed in dyeing the goods.*

Subsequently to these observations, which are perhaps interesting in an economical point of view, the yellow parmelia was recommended by Dr Sande, probably misled by the colour, as a substitute for Peruvian bark during the last French war. It has also been chemically examined by Herberger, but not apparently with the same results afforded by Scotch specimens, as he found no inorganic constituents which amount to from 6 to 7 per cent., according to my trials, and obtained a much larger quantity of colouring matter than existed in any plants examined by me. He also found a red colouring matter, which did not appear in the process of extraction as followed by me, and which may therefore be a product of the oxidation of parietin. More lately still, Dr. Gumprecht extracted yellow oil from the lichen, but in such minute quantity as not to be susceptible of examination. I obtained a quantity of sugar, by means of alcohol, in crystalline grains.

Note.—Since the preceding paper was read, the yellow needles described above have been analysed in the laboratory at Giessen, and have been found to consist of $C_{40}\ H_{16}\ O_{12}$, approaching one of the analyses already detailed. So that we have now the following oxides:—

Oil of parietin, ...	$C_{40}\ H_{16}$
Parietic acid, ...	$C_{40}\ H_{16}\ O_{12}$
Parietin, ...	$C_{40}\ H_{16}\ O_{14}$
Oxide of parietin, ...	$C_{40}\ H_{16}\ O_{16}$

* Kongl. Vetenskap, Acad. xii. p. 300, Ann. 1791.

20*th December*, 1843,—*The* President *in the Chair.*

The following members were elected:—Messrs. Robert Stewart, John Geddes, James Connell, and Alex. Grant.

Mr. Keddie reported that the Botanical Section had met for the first time on the 18th, when the office-bearers were chosen. He also read the following:—

Report of Botanical Section, 18*th Dec.*—Dr. Balfour *in the Chair.*

The Botanical Section met for the first time on Monday evening. Office-bearers were appointed—a list of whom has been given in to the General Secretary.

Mr. Gourlie presented to the herbarium specimens of Cryptogamic plants, from British Guiana, gathered by Dr. W. H. Campbell.

Dr. Balfour presented specimens of *Juncus subverticillatus, Sagina apetala,* β glabra, and *Impatiens fulva,* from Sussex.

Dr. Balfour read a letter from Professor Connell of St. Andrews, giving an analysis of the substance called vegetable ivory, the product of a palm named *Phytelephas macrocarpa.* Mr. Connell has determined the presence of an azotised substance, which seems to have all the properties of vegetable casein. He has also detected vegetable albumen and oily matter. Specimens of the fruit of the ivory palm, and of the horny seed of the Doom palm, were exhibited.

Dr. Balfour also read extracts from a communication by Mr. J. Ralfs, of Penzance, on the natural order *Desmidiaceæ.* This order includes plants which are closely allied to the lowest classes of animals, and have been looked upon by Ehrenberg and others as of an animal nature. Mr. Ralfs considers them as distinct from the *Diatomaceæ,* under which tribe they have been usually included. The latter have a siliceous covering, and, after being gathered, quickly acquire an offensive odour; while the desmidiaceæ have no siliceous covering, and are remarkable for the length of time during which they may be preserved in a moist state without material change.

The desmidiaceæ are minute plants, formed in fresh water, and often forming finger-like tufts at the bottom of pools. They consist entirely of cells, which divide in a remarkable manner, and thus give rise to peculiar motions, which have led some authors to consider them of an animal nature. Mr. Ralfs, however, shows that these motions by division take place in many true algæ. He also shows that the desmidiaceæ exhibit distinct evidences of the presence of starch on addition of tincture of iodine; and on this account, too, he considers them as of a vegetable nature.

The views of Meyen, Dalrymple, and Bailey were brought forward and discussed. Mr. Ralfs reconciled conflicting opinions, by showing that starch granules are only to be detected at certain periods of growth. Specimens of *Closterium Digitus*, with the starch granules changed into blue by iodine, were exhibited under the microscope.

Dr. Balfour also exhibited under the microscope specimens of Desmidiaceæ and Diatomaceæ, and illustrated the paper by drawings of plants belonging to these orders.

A communication was then read by Professor Gordon on the Application of the Calculation of Probabilities in the Formation of Science.

3*d January*, 1844,—*The* President *in the Chair.*

The following statement of the estimated revenue and expenditure for the current year was laid before the Society:—

Annual Revenue, exclusive of Entrance Fees, . .		£100 0 0
Surplus of 1842–3, ...		35 10 0
		£135 10 0
Estimated Expenditure:—		
By Publications ordered, . . .	£25 3 10	
Publishing Proceedings, . . .	55 0 0	
Ordinary Expenses, including Rent, .	30 0 0	
Estimated Rent at Martinmas, . .	7 10 0	
		117 13 10
Leaving a Balance of		£17 16 2

The following paper was then read:—

XLIV.—*On the Laws of Mortality at Different Ages. By* Alexander Watt, LL.D., *City Statist.*

In a paper which was published in the Proceedings of this Society last year, I showed, from the returns obtained from different towns in England and Scotland, that the amount of deaths by various diseases is nearly identical at the same ages; and that whatever the total amount of deaths by each disease may be, the proportion which the deaths falling at certain periods of life bears to the whole deaths by these respective diseases, remains the same. The examples given in that paper related to fever, measles, small-pox, and bowel complaints. As the law which was deduced from these examples appeared to be of great interest, it became an important point to determine whether it was of more general application, since a knowledge of the specific laws of mortality by such diseases at different ages, by determining more clearly the nature and operation of the disease, may be expected to lead both to improved modes of medical treatment, and to facilitate the introduction of such sanatory regulations, as would ensure to the inhabitants of our cities one of the most important of social blessings—a healthy population. Through the kindness of William Mills, Esq., formerly Lord Provost of Glasgow, I have been enabled to compare my former tables with data which I have calculated from the mortality bills of New York and Philadelphia. From such comparative results we are enabled to distinguish at a glance the modifications which diseases undergo in different climates. One of the most interesting diseases is fever, on account of its frequent occurrence in this country, and more especially in Glasgow, where it seems to serve as a test of destitution.

FEVER.

In the bills of mortality for New York and Philadelphia, the mortality by the different species of fever being judiciously given separately, we are enabled to select the species corresponding with those registered under the head of fever in the Scottish towns. The following table exhibits the comparative mortality from fever in Edinburgh and Glasgow, and from fevers, exclusive of puerperal and scarlet fevers in New York and Philadelphia. For typhus fever, see Glasgow Mortality Bill, 1842.—

	Edin. per cent.	Glas. per cent.	N. York. per cent.	Philad. per cent.	Manch. per cent.
Deaths under 5 years to the whole deaths by fever, .	12·41	12·07	15·67	17·34	16·08
Do. under 20 years,	29·74	29·05	30·22	33·03	38·48
Do. 20 and upwards,	70·25	70 94	69·77	66·96	61·51

In the above table the per centage for New York was deduced from 1416 cases, and that of Philadelphia from 663 cases. The greatest difference appears to be at the lowest ages, where the mortality in America is higher. Similar results frequently occur in this country, where the disease is less prevalent, as in 1842 in Glasgow, when the mortality under five years was 18·58. During that year it is well-known that there was a smaller proportion of deaths by typhus than usual.

MEASLES.

The following table affords an extended illustration of the same law which was pointed out in the last paper published in the "Proceedings," and shows that the number who die of measles is nearly the same at the same ages in different towns:—

	Glas.	Edin.	N. York.	Philad.
Under two years, . .	52·76	60·25	47·48	45·76
Do. five years, . .	88·08	92·30	90·09	89·83
Do. twenty years, .	99·35	99·67	98·27	99·43
Above twenty years, .	0·64	0·32	1·72	0·56

The total amount of deaths in each of these towns was very different, and yet it will be observed that the proportions of deaths at the different ages to the whole deaths by measles, are very nearly the same in each of these towns; the variation being chiefly at ages under two years.

SCARLET FEVER.

The following table exhibits the per centage proportionate amount of deaths by scarlet fever at different ages in various towns, to the whole deaths by that disease in each town respectively:—

	Glas.	N. York.	Philad.
Under two years, . . .	35·40	30·12	30·69
Do. five years, . . .	70·95	76·75	75·49
Do. twenty years, . .	97·95	91·39	97·77
Above twenty years, . .	2·04	2·60	2·22

Similar examples to the above are given for other towns of England and Scotland in the Vol. of the British Association Transactions for 1842. The same law is applicable in all the localities examined. That the proportions of deaths by scarlet fever at the different ages to the whole deaths should be so nearly the same in New York and Philadelphia is remarkable; and although the amount for the lower ages differs from Glasgow, there is no doubt sufficient reasons for this variation.

SMALL-POX.

In this table we have compared the proportionate amount of deaths by small-pox per cent. at different ages in various towns, to the whole deaths by that disease in each town respectively:—

	Glas.	Edin.	N. York.	Philad.
Under two years, . .	57·76	53·24	34·11	34·39
Do. five years, . .	85·72	82·68	58·66	57·14
Do. twenty years, .	95·12	95·23	72·74	77·24
Above twenty years, .	4·87	4·76	27·25	22·75

From this table it appears that the proportion of deaths by small-pox to the whole amount of deaths by that disease in New York and Philadelphia, at the same ages, is very different from the proportion of deaths by the same disease in the towns of this country; the proportions under two years of age being above twenty-three per cent. less in New York and Philadelphia than in Glasgow. There is, of course, a corresponding increase in the proportion of deaths at the higher ages; yet it must be observed that the proportion of deaths by this disease at the early ages is the same in Philadelphia as it is at New York—

affording another strong proof that there are physical laws which regulate the amount of deaths at different ages by the various diseases, when unimpeded by local causes. It is highly probable that inattention to early vaccination may be the immediate cause of a greater mortality at the higher ages in America than in this country. A difference in this respect exists also between the towns of England and Scotland. The proportion of deaths above twenty years of age by small-pox in Manchester amounts to 1·687 per cent. of the whole deaths by that disease, and to 2·316 per cent. in Liverpool, whereas the proportion above that age cut off by small-pox amounts to 4·479 per cent. of the whole deaths by that disease in Glasgow, and to 4·761 per cent. in Edinburgh. However much this effect in Glasgow and Edinburgh is produced by inattention to vaccination, the evil is very much the same in both cities, so far as the proportion at the higher ages is taken into account. It appears also from the returns that the proportion of deaths by small-pox to the population in Edinburgh is not half so great as that in Glasgow; and as small-pox is much more destructive in some years than in others, and as the comparison only extends over three years for Edinburgh, and over five years for Glasgow, this comparison of the total amount of deaths by small-pox may be more favourable to Edinburgh than it ought to be.

HOOPING-COUGH.

This table shows the amount of deaths from hooping-cough under and above certain ages in different towns, and the proportions which the amount of deaths at these ages bear to the whole amount of deaths by that disease in each town respectively:—

	Glas.	Edin.	N. York.	Philad.	Birm.
Under two years, .	66·37	66·38	67·52		
Do. five years, .	91·52	92·87	95·51	95·03	93·49
Do. twenty years,	99·77	100·00	99·78	100·00	100·00
Above twenty years,	0·22	0·00	0·21	0·00	0·00

Some of the cases above twenty years should possibly not be classed with hooping-cough. One case in Glasgow is stated as being between forty and fifty, and another between fifty and sixty. A case above twenty years, given in the New York tables, occurred in 1840, and is recorded as being between thirty and forty years of age.

(*To be Continued.*)

BELL AND BAIN, PRINTERS, GLASGOW.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

FORTY-SECOND SESSION, 1843-44.

3d January, 1844,—*The* President *in the Chair.*

XLIV.—*On the Laws of Mortality at Different Ages.* *By* Alexander Watt, LL.D., *City Statist.* (*Continued.*)

Remarks on the Tables.—The data which have been adduced seem to demonstrate that the proportions in the amount of deaths under any given age, by the diseases which have been selected for consideration, viz., fevers, measles, scarlet fever, small-pox, and hooping-cough, to the whole amount of deaths by each disease respectively, are almost identical, although the total amount of deaths by the same disease is very different in each city. In some instances where the circumstances of the people vary much from each other, a corresponding variation takes place in the mortality at the same ages. This is peculiarly exemplified by the deductions, in reference to small-pox, from the New York and Philadelphia mortality bills; but notwithstanding the great difference between the results in America and in Scotland in the mortality from this disease, it is important to observe that the proportion of the deaths by this disease in New York exactly corresponds with those for the same age in Philadelphia—the circumstances of these towns in relation to small-pox being much alike. The variations in the higher ages may probably depend on causes capable of detection on further inquiry; and such interferences being allowed for, the intimate correspondence of the results pointed out, cannot be looked upon as accidental, but as the result of precise laws which regulate the amount of mortality at every age.

Two causes must be especially considered as having a constant tendency to effect a certain variation in these results, viz., medical treatment, and a proper supply of wholesome and nutritive food

Though it appears from these results that the medical practitioner does not possess that indiscriminate command over the life of his patient that has sometimes been ascribed to him, yet it is very apparent that, by judicious treatment, the medical man has much in his power in the way of placing the system of his patient in the most favourable circumstances for resisting the effects of the disease. If the patient, however, has been previously reduced by a scanty or improper diet, it may become difficult, perhaps even impossible, to supply the remedy under such circumstances; therefore it might be apprehended that even greater variations should occur in these proportions than are indicated by the details which have been discussed; but we must bear in mind that the practice of the medical man is not limited to individuals of a particular age, but is extended to whole families; and in a similar manner, where destitution prevails, it very generally falls upon families at all ages as well as upon particular persons.

An acquaintance with the laws of mortality which we have now considered, will not only aid us in arriving at a true knowledge of the sanatory condition of towns, and enable us to point out the remedies for excessive mortality, but they will assist us also in guiding the medical practitioner in the proper treatment of his patient. A knowledge of these laws is also necessary for the construction of proper annuity and life assurance tables. Any calculations that are wholly founded on the average of life in other countries must necessarily be more or less fallacious, as it is obvious that the average duration of human life must vary with the diseases which are most prevalent in the country; and it is well known that many countries, and even many districts, have diseases more or less peculiar to themselves, and differing in their law of mortality.

17*th January*, 1844,—*The* PRESIDENT *in the Chair.*

Mr. John Morgan was admitted a member. On the motion of Mr. Liddell, seconded by Dr. Watt, Mr. William Keddie was appointed Assistant-Secretary.

A letter was read from the Lords of Her Majesty's Treasury acknowledging the receipt of the Society's memorial in favour of completing the Trigonometrical Survey of Scotland, and stating that "the secondary triangulation for the survey of Scotland is in progress in the county of Wigton; and that instructions have already been given to take the proper measures for ascertaining the legal boundaries, preparatory to the introduction of such a force of surveyors as the sum which it will be practicable to allot, in future years, for the operations of the survey in Scotland, out of the amount voted by parliament for completing the ordnance surveys in Great Britain and Ireland, may allow of."

It was agreed that a conversational meeting of the Society should be held on the 21st of February.

The 6th Part of the Proceedings of the Chemical Society was received on the part of that society. Thanks were voted, and for the 1st vol. of the Proceedings of the same society, previously presented.

Mr. Liddell exhibited and described the Vesta lamp for burning camphine; also, a new hydrostatic lamp, for burning oil. The liquid termed camphine possesses the odour of oil of turpentine. Its specific gravity is ·864. It begins to throw up bubbles of vapour at 160°, and continues to boil up to 314°, when its point of ebullition remains stationary. It has, therefore, all the characters of oil of turpentine.

The following communication was made:—

XLV.—*Table of the Specific Gravities of some Crystallized Salts.* *By* MR. JOHN ADAM.

IN the following table the specific gravities were determined by weighing the finely crystallized salts, first in air and then in pyroxylic spirit, of the sp gr. ·824, alcohol of the sp. gr. ·8393, and turpentine sp. gr. ·870. The spirit produced no acid reaction on litmus paper.

The first column represents the specific gravities referred to pyroxylic spirit. The second, the same gravities reduced to water as the standard; the third column exhibits the specific gravities in alcohol; and the fourth the same densities referred to water. The two last columns were made by Dr. R. D. Thomson, with a different beam from that used in constructing the first columns, and generally with different specimens.

	To Pyroxylic Spirit, sp gr. ·824.	To Water.	To Alcohol and Turpentine.	To Water.
Sulphate of potash	2·695	2·220	2·614	2·194
Do. large crystal	2·651	2·184	—	—
Anhydrous sulph. of soda	2·755	2·270	2·667	2·238
Sulphate of soda	(soluble)	—	1·467	1·231
Sulphate of zinc	—	—	*T1·899	1·652
Sulphate of magnesia . .	1·629	1·342	1·656	1·389
Nitrate of potash	2·016	1·661	1·962	1·646
Nitrate of soda	—	—	T1·973	1·716
Nitrate of barytes . . .	—	—	T3·052	2·655
Nitrate of lead	—	—	T4·561	3·968
Chloride of sodium . . .	—	—	T2·138	1·860
Chloride of potassium . .	—	—	T1·848	1·607

* T denotes oil of turpentine.

	To Pyroxylic Spirit, sp. gr. ·824.	To Water.	To Alcohol and Turpentine.	To Water.
Chloride of lead	—	—	T4·918	4·278
Iodide of potassium . . .	—	—	T2·792	2·489
Chromate of potash . . .	—	—	T2·572	2·237
Bichromate of potash . .	2·599	2·141	2·563	2·151
Carbonate of soda . . .	1·477	1·217	1·462	1·227
Ammoniacal alum . . .	1·644	1·354	1·667	1·399
Manganese alum	—	—	1·729	1·451
Potash alum	1·667	1·373	1·684	1·414
Yellow prussiate of potash	1·859	1·531	1·868	1·567
Red prussiate of potash .	1·768	1·456	1·785	1·498

Mr. Stenhouse exhibited some salts of meconic acid which he had prepared and analysed.

31*st January*, 1844,—*The* President *in the Chair.*

Messrs. William Smith and William Wilson were admitted members of the Society.

The following paper was read.

XLVI.—*Note on the state in which Fibrin exists in the Blood. By* Andrew Anderson, M.D., *Andersonian Professor of the Institutes of Medicine.*

It has for some time been the general opinion among physiologists, that the fibrin of the blood is liquid during life, and becomes solid only when that fluid dies; and this opinion is based on the well-known experiment, first performed by Müller, of filtering frog's blood before its coagulation, and thus obtaining the clot separate from the globules, which remain behind on the paper. At the meeting of the British Association at Glasgow, Dr. A. Buchanan exhibited a method of showing the same thing in human blood, by receiving it from the vein into a vessel of serum, in which the globules subside before coagulation.

The common notion of the change which takes place on coagulation has been well expressed as follows:—

$$\text{Living blood}\left\{\begin{array}{l}\text{Plasma}\left\{\begin{array}{l}\text{Fluid}\\ \text{Fibrin}\end{array}\right.\\ \text{Globules}\quad\text{—}\end{array}\right.\quad\left.\begin{array}{l}\text{Serum}\\ \\ \text{Clot}\end{array}\right\}\text{Dead blood.}$$

From this opinion there have recently dissented M. Mandl* and

* Anat. Microscopique, Art. Sang. 1842.

Dr. A. Buchanan.* These gentlemen hold, that while of the corpuscles of the blood the *red* take no part in the coagulation, and are merely engaged as it were by accident in the clot, from which, by the above mentioned means, they may be artificially excluded; yet the *white* corpuscles and the *molecules* which exist in the fluid, really constitute the fibrin: and that the coagulation consists simply in the aggregation of these previously isolated bodies. Dr. Buchanan's opinion to this effect is based, not upon the direct examination of the process of coagulation in the blood, but upon what he conceives to occur in the case of the fluid of blisters and of serous cavities, and to furnish an analogical argument of considerable weight.

Now, it is true that the fluid of blisters contains corpuscles like the white globules of the blood, and also that it coagulates on standing; and it may be likewise true, that the number of the corpuscles is in the ratio of the size of the clot: but I have carefully watched the fluid of a recent blister coagulating under the microscope, and find that the delicate clot forms independently of the corpuscles, as it is seen to occupy the whole area of the field of view, while at most two or three corpuscles may be scattered over it.

Again, it is true that in the very curious experiment which we owe to Dr. Buchanan, the mixture of the serum of blood and of that of hydrocele, exhibits after standing for some time a marked coagulum; but I submit that neither is this a proof that that coagulum is derived from the corpuscles existing in the fluid in which it forms; for I have divided such a mixture into two equal parts, and while leaving one untouched have separated by filtration all the corpuscles from the other, while still fluid, and tested their absence by the microscope, and yet the eye could detect no difference between the coagula subsequently formed in the two portions—nor, when aided by the microscope, any corpuscles newly formed.

But the *experimentum crucis* is the examination of the changes which occur in the plasma of the blood itself; and this may be effected by removing with a spoon a portion of the incipient buffy coat, (the whitish fluid which floats before coagulation on the surface of inflammatory blood,) and placing it under the microscope. This fluid is the blood *minus* the red corpuscles, which, as Mr. Wharton Jones has shown,† attract one another more strongly in inflammatory than in healthy blood, and sink rapidly in the fluid. Our view, then, of the changes which occur being no longer obscured by their presence, we watch the plasma swarming with molecules and white corpuscles, the latter always most abundant in inflammation, as may be seen even by placing a drop of the just abstracted blood under the microscope between two plates of glass, to which the

* Proceedings of the Glasg. Philos. Soc. 1843, p. 131.

† Ed. Med. and Surg. Journal, 1842.

white corpuscles stick because of their greater size, while the red (known by their smooth outline, their central nuclei, elongated profile, and, even under the microscope, pale yellowish colour,) rush beautifully past them, like fragments of floating things carried against a buoy moored in a strong tideway. As we watch the plasma it has become partly solid, but no visible change appears; the corpuscles remain quite still, and it is only by drawing across the glass a needle, which carries the whole in a mass along with it, that we find that they are engaged in a thin coagulum. There is then no running together of the corpuscles; but so far we are still in doubt whether the clot may not be formed by their cohesion: the doubt is resolved by simply continuing to look: we have drawn aside the forming clot before its solidification was complete; and have left a clear fluid *perfectly free* of corpuscles of any kind, and yet in this again the coagulation takes place; it must, therefore, be from a solidification of the previously fluid fibrin.

So far my observations agree with those of Dr. Addison,* published after mine had been made; but he states that the fibrin solidifies in the form of fibres, and figures these of a somewhat stellate or spiculate appearance. In the existence of this sort of crystallisation I wholly disbelieve. I have repeatedly seen the whole field of view occupied uniformly by the extremely delicate clot, so fine and transparent as to be distinctly visible only when its edge was drawn across the glass with a needle, and thus contrasted with the remaining limpid fluid; and of which the structure was so faintly fibrous, that with the greatest difficulty, in a carefully modified light, there could, with a power of 600 diameters, be just traced, distributed equally over the whole surface, a most delicate striated appearance. It is true that afterwards the coagulum becomes fibrous, but this is the consequence of a subsequent contraction, the nature of which has not been satisfactorily explained, but of which I can say only this, that save its lessened size, and a slight increase of the fibrous appearance, no change, by motion or otherwise, could be observed in a coagulum prepared as above, and allowed to remain for twenty-four hours in a covered glass cell under the microscope, till it had fully contracted, and squeezed out all the serum from its interstices.

Moreover, I must differ in opinion from Dr. Addison, when he advances it as ascertained, that the fibrinous spontaneously coagulable liquid is formed within the white corpuscles, and appears on their rupture only: there is no doubt some inseparable connexion between the presence of these corpuscles and the existence of the fibrin of the blood, for in determination of blood, and in inflammation, the increase of the one keeps pace with that of the other: and it is possible that

* Trans. of the Prov. Med. Assoc. 1843.

the corpuscles may have the function of converting the "reduced albumen"* of the food, and of the effete elements of the tissues, into organizeable fibrin, which appears first in the chyle along with these corpuscles, after that fluid has passed the mesenteric glands; and in all likelihood, first in the lymph after it has passed the lymphatic glands. Yet we find that, in the mixed serums already spoken of, the solidification goes on for days gradually increasing, in the utter absence of corpuscles of any kind, and must, it hence appears probable, be owing to the progressive formation of fibrin, and not to the mere coagulation of that already formed; for *that*, as we see in the blood, is finished within a short time of the death of the fluid. Another proof of the essential difference between the white corpuscles of the blood, and its coagulable matter, is afforded by an elegant experiment, described by M. Donnè.† This consists in agitating the blood during coagulation: the fibrin is thus separated in stringy morsels, and on leaving the remaining part to stand for some time in a tall glass vessel, the white corpuscles are found forming a thin pale layer between the red globules below and the clear fluid, to the bottom of which they have subsided. The mode in which the change in the mixed fluids takes place is yet unexplained.

I believe with Dr. Buchanan, that the increased formation of fibrin in an inflamed part, takes place *within* the vessels, and therefore in the pure plasma of the blood itself; but that it is in all likelihood effected by the agency of white corpuscles, which during inflammation become more numerous in the capillary blood-vessels, and adhere to their walls even more firmly than, in the state of health, they are wont to do; and thus throw an obstruction in the way of the red globules, which in health form a rapid current in the centre of the vessels.‡ Mere stasis does not produce the change, for in simple congestion, however much the blood may be delayed, there is no increase of fibrin—and in determination there *is* more fibrin formed, though there may be no obstruction, but rather a more rapid flow of blood: in the latter case, however, the vital nutritive action of the part is increased, in the former diminished, and this I take to be the true explanation of the increase of fibrin; holding it to be produced within the vessels by a greater activity of whatever organ (be it the white corpuscles or no) is in health charged to convert the "reduced albumen" to organizeable fibrin; an activity called into play by the increased demand for that material in the excited and over active part.

Thus, then, I think we must still believe that the coagulation of the blood forms an exception to the generality, contended for by Dr. Barry and others,§ of the law that the living tissues are formed directly from cells.

* Prout. † Cours de Microscopie, p. 84. 1843.

‡ Williams; Princ. of Medicine, p. 213. Travers; Pathology of Inflammation, &c. 1843.

§ Various Papers, Phil. Trans. 1838, 1842, &c.

How the corpuscles of serous effusions are formed we cannot yet surely say: not, probably, as Dr. Addison * supposes, by the actual passage through the walls of the capillaries of the white corpuscles of the blood. The simplest effusion which takes place from vessels is pure water, as from the Malpighian bodies of the kidneys.† When there is more pressure or excitement, serum is effused, being water with albumen in solution, as in dropsy, or renal congestion;‡ if the local excitement still increase, fibrin is thrown out, and coagulates spontaneously when withdrawn from the body, as in the fluid of blisters; § and a yet higher action of the part results in the throwing out of "lymph," or coagulable matter full of active cells, which, as in the inflammations of serous membranes, becomes rapidly organized. Dr. Addison would say that these cells are the white corpuscles of the blood, which have traversed the coats of the vessels, and go to form the plastic fibrin of the effusion; but then its plasticity ought to be in the ratio of their number, which is notoriously not the case: for pus, the most aplastic of all effusions, actually swarms with distinct corpuscles, very like those found in the blood, and yet contains no coagulating fibrin at all.

The opinion of Gendrin,|| that the pus corpuscle is formed from the red blood globule, can scarcely now be held, except it be by Dr. M. Barry; and it is extremely improbable that bodies such as the white corpuscles, which are larger than the red globules of the blood, as 1-2600th to 1-3500th of an inch, should traverse the unruptured capillary walls while the latter are retained.

The nutrition of nonvascular tissue is effected** by the transudation of nutritive matter through the coats of the looped capillaries which encroach upon its edges; and we cannot suppose that white corpuscles, even if they too transuded, should make their way onwards to the centre of a solid mass of cartilage, for instance: we must suppose that it is the plasma alone which the tissue imbibes, and by which its living cells are nourished; and so in the case of effusion it seems most probable that what really occurs is simply a transudation of that plasma, nourished by which the corpuscles grow, whether they be descended from "germinal granules," or "cytoblasts," or in whatever way they originate.

The "molecules" and "granules," formed so abundantly in the buffy coat, exist also in healthy blood, in the serum of which they can be seen by the microscope; and in "milky" serum, such as occurs in renal inflammation, they are very abundant. Simon has shown †† that it is in part to an albuminous, and not, as Prout and Christison‡‡ supposed, wholly to a fatty matter that such serum owes its opacity; and by the microscope it can be seen to swarm with particles resem-

* Loc. Cit. † Bowman, Phil. Trans. 1842. ‡ Robinson, Med. Chir. Trans. 1843.
§ Dr. Buchanan, loc. cit. p. 133. || Sur les Inflam. ii. 472.
** Toynbee, Phil. Trans. 1842. †† Beitraege, &c. Lief. 1.
‡‡ On Granular Degen. of the Kidney.

bling the molecules of the blood, rather than with the chyle globules which Gulliver describes,* though no doubt these may in certain cases exist. Dr. Andrew Buchanan† has discovered a method of separating this albuminous matter, and causing it to float on the surface of the fluid, when it puts on all the appearance of the amorphous substance found in what Hodgkin‡ calls the nonplastic serous effusion. Do such effusions depend on the superabundance of this matter in the blood, as the more plastic forms are owing to increase in the coagulable fibrin, and is the well known action of mercury in making the plastic become the aplastic effusion, owing to some "reducing" action by which it tends to make the protein compounds of the blood less fibrinous, and more like common albumen?

It is evident that in the blood we have several forms of these compounds, deserving of much separate investigation, as:—

1. Albumen—coagulable by heating the serum.
2. "Serolin" remaining in the solution, mixed with urea, salts, &c. —and which Mulder, with what truth I know not, avers§ to be a tritoxide of protein.
3. Fibrin—procured by agitating fresh blood.
4. White molecules—procurable by Dr. Buchanan's method from "milky" serum.
5. White corpuscles—probably procurable by a like method from the yet fluid buffy coat.
6. Hematosin dissolved out by water from the red globules.
7. "Globulin," or the coats and nuclei of these globules, which subside to the bottom when hematosin remains dissolved.

All these substances must be separately analysed, if we would perfect our knowledge of the blood: but it were an error to fancy that they must needs be exactly the same in all cases—even if in the same way procured. Mulder‖ tells us that the buffy coat is not pure fibrin, but a mixture of the deutoxide and tritoxide of protein: I cannot tell how this may be; but I know that it is not in the globules alone that we find a varying attractive or cohesive power. In inflammation, as Jones has shown,** the mutual attraction of the red corpuscles is increased, so that they withdraw from the floating plasma; but the solidifying fibrin of that plasma contracts too with a varying power: in *sthenic* inflammation, when the system is otherwise in health, the coagulum shrinks during many hours, and the buffy coat forms a tough leathery covering to the clot. In *asthenic* or *specific* inflammation, as for example in the "ophthalmitis postfebrilis,"†† occurring as a too frequent sequela of the fever lately epidemic in Glasgow, we have still the increased formation of fibrin and white corpuscles, still the greater mutual attraction of the red globules, and still the buffy coat; but it does not contract much, but

* Notes to Gerber's Anat. † See his Paper forming Article L. of this Vol.
‡ On Serous Membranes. § Annalen der Ch. und Ph. 1843. ‖ Loc. cit.
** See above. †† Mackenzie.

maintains a gelatinous appearance, a state obviously owing to a vital power of the fibrin in some way diminished.

It remains for chemistry to tell whether the ultimate analysis of such a buffy crust differs from that of the more common kind; but from the difficulty of procuring material, it is probable the question may remain long unsolved.

But we have more: the red blood corpuscles have always a certain mutual attraction, clinging closely in death to one another; inflammation increases this, and likewise the quantity of fibrin and white corpuscles, and so the buffy coat is formed. But this takes place within a very few minutes: the subsequent *contraction* of the clot, by which the serum is squeezed from its interstices, is the work, *not of the globules but of the fibrin;* hence we find in one case a clot much contracted, though without a buff; in another buffy blood, of which the clot and even the buff itself is loose and soft; in still another the coagulum is soft and presents no buff; while there are also cases where the clot is small and dense, as well as clothed with a firm leathery crust.

The first occurs in sthenic states, where the fibrin is highly vitalised, but no inflammation is present—in plethora for instance: the second, where we have inflammation with an asthenic state of the system—as in the postfebrile ophthalmitis: the third, where much debility exists, without any local inflammation—as in fever: and the fourth, where, as in sthenic acute inflammation, there is a local disease, and an active state of the system besides.

These differences point at some element of the doctrine of the properties of blood, which it will go hard if chemistry alone can explain.

FIG. 1.

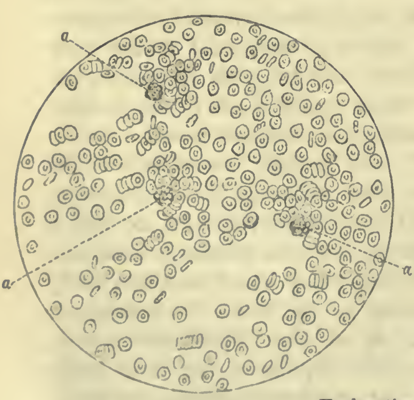
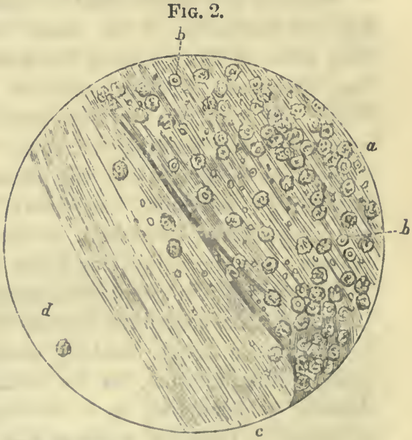


FIG. 2.



Explanation of the Figures.

Fig. 1.—Three white corpuscles (*a*, *a*, *a*,) are seen sticking to the glass in the field of view, while the red corpuscles rush rapidly past. (Inflammatory blood before its death.)

Fig. 2.—The coagulation of the buffy coat: *a*, the white corpuscles and molecules; *b*, a few red corpuscles; *c*, the striated coagulum, formed after the removal of the corpuscles; *d*, the clear space containing serum.

ANTARCTIC MINERALS.

Dr. R. D. Thomson exhibited specimens of minerals presented to him by Dr. Joseph Hooker, which he had collected at the Falkland Islands, Kerguelen's Land, New Zealand, and other places visited by Captain Ross' expedition. Captain Sibbald, late of H.M.S. Erebus, one of the vessels engaged in the expedition, was present, and assisted Dr. Thomson in pointing out the course of the voyage on a chart, and the points from which the specimens were derived.

The following are the analyses of some of the specimens:—

OBSIDIAN.

This specimen was from Ascension, and was analysed by Mr. James Murdoch, in the College laboratory.

Silica,	70·97
Alumina,	6·77
Peroxide of iron,	6·24
Lime,	2·84
Magnesia,	1·77
Soda and potash,	11·41
	100·

This analysis closely approximates to the result obtained by Berthier, from a specimen procured from Pasco in Columbia,* but differs considerably from the composition of obsidians from Iceland and Mexico, which contain 10 per cent. more silica.

Mr. James Murdoch also analysed a zeolite, from Kerguelen's Land, which proved to be a white stilbite. The geological conformation of this island appears to be volcanic, both from this circumstance, and from a specimen of porphyry or volcanic slate, among the collection, which was also exhibited.

NEW ZEALAND OCHRE.

This substance, which is a fine yellow pulverulent ochre, is described by Dr. Dieffenbach † as occuring near Mount Egmont, many hundred feet above the sea in the bed of a stream; and as being used by the natives to paint their bodies in time of war, their houses and canoes. It was analysed by Mr. George Aitken in the College laboratory, and its composition found to be as follows by two analyses:—

* Thomson's Mineralogy, I. 394.

† Travels in N. Zealand.

Sp. gr. 2·24.

	I.	II.
Peroxide of iron, . . .	59·56	64·36
Silica, ...	14·56	13·92
Water, ...	20·20	
Vegetable matter, . . .	4·72	
Alumina, ...	a trace.	
Lime, . . .	a trace.	
	99·04	

When digested with muriatic acid, it partly gelatinizes.

14*th February*, 1844,—*The* PRESIDENT *in the Chair.*

A letter was read from Mr. John Craig, stating his intention of publishing a work by subscription, on the geology of the Western division of the Great Valley of the Scottish Lowlands.

Mr. Keddie exhibited to the Society, in the absence of Dr. Penny, specimens of sulphur from Sicily. A specimen, analysed by Mr. Boyd, in his laboratory, was found to consist of

Sulphur, ...	48·
Carb. of lime, ...	46·5
Carb. of magnesia, . . .	3·7
Alumina and oxide of iron, . .	·6
Silica, ...	1·
	99·8

Dr. R. D. Thomson presented to the Society the Annual Report of the Registrar General for 1842; also Quarterly and Weekly Tables of Mortality for 1843 and 1844.

The following communication was read.

XLVII.—*Note on the Measure of Impact, by pressure or weight. By Professor* L. GORDON.

THE object of this note was to point out that some recent attempts to measure the force of impact *absolutely* by the registered indication of a spring dynamometer, would give only comparative results, varying for each particular spring used.

Supposing the spring's elasticity to be such, that equal pressure produced equal elongations, it was demonstrated that its registration under the influence of a weight suddenly brought upon the dynamometer, and its acquired velocity, would be double the elongation due to the weight, supposing all acceleration of motion carefully prevented.

If the weight be let fall from a certain height, elongating the spring by *impact*, it was shown that *registered elongation, or maximum elongation* would exceed that due to the weight W, by a quantity *equal to a mean proportional between this elongation, and the same increased by double the height fallen through.* This latter *mean* is the direct measure of the influence of the inertia of W, or its momentum, the mechanical effect accumulated in the dynamometer spring.

28th February, 1844,—*The* President *in the Chair.*

Messrs. George Greig, Alex. M'Nab, and George Lish, were admitted Members of the Society.

A vote of thanks was given to Mr. William Murray, Convener, and the other members of the Committee who made the arrangements for the conversational meeting held on the 21st.

A spirit lamp without a wick, belonging to Professor Maconochie, was exhibited, and explained by Dr. Balfour. It consisted of a metallic saucer, in which the spirit is deposited, and of a semi-globular cap, with a central perforation, which fits into the former.

Mr. Keddie gave in a Report of the monthly meeting of the Botanical section held on the 26th.

The following paper was read.

XLVIII.—*Short account of a Botanical Excursion to Galloway and Dumfriesshire, in August,* 1843. By J. H. Balfour, M.D., *Regius Professor of Botany.*

Believing that an account of an excursion through some of the richest botanical counties in the Lowlands of Scotland, will not be uninteresting, more especially when accompanied with the exhibition of specimens, I have been induced to bring the following communication before the members of the Philosophical Society.

The pleasure which we derive from excursions like that I am now to notice, enhances in no small degree the interest of our botanical pursuits. The very sight of the specimens we collected recals many pleasing associations; and these dried forms of vegetable existence tell more eloquently than words, many a tale of adventure by flood and field.

The examination of the Flora of a country is an object of importance, as leading to the determination of interesting points connected with botanical geography. In the excursion through the counties of Wigton, Kircudbright, and Dumfries, our party bore this object steadily in view, and we have been able to make up a pretty full catalogue of the plants of the district. The plants collected were in many cases rare, and one or two of them are not found in any other counties in Scotland.

The party left Glasgow by the train for Ayr, on Wednesday, 9th August, 1843, and after botanizing for a few hours in the neighbourhood of that town, proceeded to Portpatrick. On visiting the Low-Green at Ayr, we picked Atriplex laciniata, in great abundance, along with Eryngium maritimum, Sinapis monensis, Senebiera Coronopus, and a few specimens of Iberis amara. We looked in vain for Trifolium ornithopodioides, which used to grow abundantly on the Green in some places. Our walk extended along the shore as far as the Heads of Ayr. Near Grinan Castle, we found Trifolium scabrum, but no other plant of particular interest attracted our notice. On returning towards Ayr, we saw very large specimens of Equisetum Telmateia of Ehrhart, some of them nearly six feet high growing on a bank close to a ditch.

From Portpatrick we proceeded along the shore by Port Kale and Blackhead, to Kilintringan, and Knock Bay. The rocks along the shore are bold and precipitous, and consist chiefly of greywacke schist and greywacke conglomerate, presenting in many instances a peculiar twisted appearance. Some of the rocks project in the form of narrow ledges, on which it is scarcely possible to balance oneself; others rise in the form of conical peaks, which are quite inaccessible. The same kind of rocks prevails along the whole of the shores of Wigtonshire and Kircudbrightshire, with occasional patches of old red sandstone, and some granitic rocks, as at Creetown and Criffel, and occasional masses of porphyry and trap. Among the plants noticed near Portpatrick, were Carlina vulgaris, Hypericum Androsæmum, Scilla verna in fruit covering the rocks profusely, and no doubt presenting in the earlier months a beautiful appearance with its blue blossoms, Juncus maritimus, Ligusticum scoticum, Œnanthe Lachenalii which along with the plants mentioned, is abundant along the shores of Wigtonshire. Mr. H. C. Watson, in his Flora of Wigtonshire, alludes to Œnanthe peucedanifolia as being found here, but in this he is mistaken, and I fear he has been misled by myself and some other Edinburgh botanists, who previously visited this county, and who mistook the Œ. Lachenalii for Œ. peucedanifolia. The distinction between these two species seem, however, to be by no means well ascertained.* Sedum Rhodiola occurs on the rocks, along with Armeria vulgaris and Cochlearia officinalis. The three last mentioned plants are interesting, as being found both in elevated alpine situations, and in the immediate vicinity of the sea.† Solanum Dulcamara, and

* A paper on the genus *Œnanthe* is about to be published by Mr. John Ball, in which he endeavours to point out the distinctions between Œ. Lachenalii, pimpinelloides and peucedanifolia. The distinctions depend on the form of the roots, the disposition and proportion of the leaves, and the presence or absence of the thickened summit of the pedicel. The first mentioned species appears to be common in Britain. The paper will appear in the Annals and Magazine of Natural History.

† Dr. Dickie of Aberdeen states, that he found by chemical examination of specimens of *Armeria vulgaris* from the sea-shore, and of others from the inland and higher

Erythræa linarifolia are also found on this shore. The latter plant is found in many situations on the west coast, such as the shores of the island of Arran.

On leaving the shore, the party proceeded inland towards Galdenoch, and thence to Lochnaw. At the latter place, through the kindness of Sir Andrew Agnew, and with the assistance of Dr. Greville, and the Rev. T. B. Bell, we were enabled to examine the loch in the neighbourhood of the castle. We were rewarded with specimens of Lycopus europæus, Sedum rupestre, Potamogeton prælongus, Sparganium natans, Callitriche autumnalis, Epilobium angustifolium, Eleocharis multicaulis, and Prunus insititia in fine fruit.

On the 11th, after picking Ophioglossum vulgatum, Botrychium Lunaria, and Senebiera Coronopus, in stations near Portpatrick, pointed out by the Rev. Mr. Urquhart, we proceeded by the shore towards the Mull of Galloway, where we meant to take up our quarters for a day or two. We visited the ruins of Dunskey Castle, placed on remarkable rocks projecting into the sea, and thence walked to Port Spittal, and Port Float. The greywacke cliffs along the shore present characters similar to those exhibited by the rocks to the north of Portpatrick.

Between Dunskey Castle and Portpatrick, Orobanche rubra was observed. This plant is usually associated with basaltic rocks, at least, if I may judge from the localities near Edinburgh, in the Hebrides, and in Ireland. In the present station, it appeared to grow on Greywacke, but I fear the observations made were not sufficiently accurate. Along with it we noticed Agrimonia Eupatorium. We also picked Isolepis Savii, an abundant plant in Wigtonshire, Euphorbia portlandica, Lamium intermedium not previously known I believe to exist here, Pyrethrum maritimum, which may possibly be a peculiar maritime variety of P. inodorum, Radiola millegrana, Daucus Carota in a remarkably dwarf and fleshy state, resembling D. maritimus, Euphrasia officinalis assuming also a thickened and diminished appearance, from its vicinity to the sea, Anagallis tenella in all wet spots, and Anagallis arvensis in the fields.

From Port Float we walked to Chapel Rosan Bay, and thence, by Logan House, to Port Logan, or as it is sometimes called, Portnessock. After paying a visit to the famous fish pond, we proceeded to Kirkmaiden and Drumore. We gathered during this part of our walk several common species of Salix, Euonymus europæus, Hieracium inuloides, Conium maculatum, Lepidium Smithii on every road-side, Helosciadium nodiflorum, or, as some may call it, H. repens, for it appears to me that the distinctions between these species are by no

districts of Aberdeenshire, that the former contained iodine, and that soda was more abundant in them, while potash prevailed in the latter. Annals and Mag. Nat. Hist. vol. xi, p. 74.

means well made out, Ligustrum vulgare, Vaccinium Oxycoccos, Carduus tenuiflorus, Stachys ambigua—a very doubtful species intermediate between S. palustris and sylvatica. In the neighbourhood of a garden we observed, Inula Helenium and Senecio saracenicus.

On the 12th we proceeded to Killiness Bay and Point, and picked Orchis pyramidalis and Convolvulus Soldanella among the bent on the sandy shores, and Polygonum Raii among the gravel on the beach. The first mentioned plant has been nearly extirpated from this locality by the rapacity of botanists. Our party only took one specimen each, leaving others in flower and seed. Near Maryport there is profusion of Raphanus maritimus, probably a variety of R. Raphanistrum, marked by its torulose necklace-like siliqua, and its large lyrate lower leaves. Helosciadium nodiflorum was very vigorous and abundant here, and Verbascum Thapsus occurred frequently.

We next directed our steps, by East Tarbet, to the Mull of Galloway, and visited the lighthouse near the point. The weather being very calm, and the sea smooth, we were enabled to descend the cliffs below the lighthouse, and to avail ourselves of a fishing boat in visiting some of the least accessible parts of the rocks. Here we got Crithmum maritimum or the common samphire, Inula crithmoides or the golden samphire, Apium graveolens or wild celery, and Statice spathulata in profusion. We failed in getting Halimus portulacoides, which grows on inaccessible cliffs at the Mull. The same species of plants occur profusely on the opposite coast of Ireland. Landing at West Tarbet we found Crambe maritima or the native sea kale. We now proceeded along the shore to Cardrain, and saw excellent specimens of Euphorbia portlandica. Here, too, we picked Oxytropis uralensis in fruit on the edge of the cliffs, and in doing so no small exercise of caution was called for; all the accessible specimens were eaten in a greater or less degree by sheep. The station for Ononis reclinata was visited, but only four specimens were procured. This plant seems to be another of those rarities which have been unwittingly extirpated by botanists. Mr. M'Culloch, a farmer in the neighbourhood, has preserved some specimens of the plant in his garden, and means to sow the seed on the cliffs with the view of preventing the plant from disappearing entirely. Geranium sangineum on the cliffs exhibits a peculiar viviparous appearance, in place of producing flowers. A glaucous variety of Festuca, probably F. ovina var. cæsia, is common in many places. Alisma ranunculoides and Hypericum elodes occur in marshy spots near the cliffs.

Leaving Cardrain, we visited Kindraw Hill and Dunman, and returned by Portencorckchrie Bay to Drumore, but did not meet with any plants of peculiar interest. The sea shore and the rocks in its immediate vicinity seem to be the most productive parts of the county.

On the 14th, we bent our steps by the shores of Luce Bay, to Grenan Craigs, New England Bay, Chapel Rosan Bay, and the sandy shores near Stoneykirk, to Mid-Tors, and thence to Glenluce. Many species of Rubus such as R. leucostachys, corylifolius, and macrophyllus were observed, also Alsine marina, Atriplex laciniata, Carum verticillatum, especially in marshy spots near Glenluce. At Mid-Tors, in a ditch, Utricularia minor, Hypericum elodes, and Ranunculus hederaceus occur in profusion, and, on the moors in the neighbourhood, Drosera longifolia and Rhynchospora alba. On the shores of Luce Bay several varieties of Chenopodium album occur, one of them with undivided leaves resembling C. polyspermum, also Glaucium luteum, Triticum loliaceum, Humulus Lupulus, Vicia sylvatica, Geranium robertianum, var. purpureum, Sparganium simplex, Isatis tinctoria (cultivated for dye), Isolepis fluitans, Mentha viridis, and Petroselinum sativum. In fields near Glenluce, Echium vulgare and Ornithopus perpusillus were found. On visiting the old Abbey of Luce we procured specimens of Lithospermum officinale. The evening of this day was the only occasion on which rain fell during our trip.

August 15.—Directing our course towards Auchenmally Bay, we passed Synnyness castle, and on our way picked Chelidonium majus, Rubus suberectus, and some varieties of Chenopodium album. On the shore at Auchenmally Bay, near the inn called the Cock, we found profusion of Blysmus rufus, Carex extensa, Juncus maritimus, Erythræa linarifolia, Littorella lacustris, Scutellaria galericulata, Scirpus maritimus, Sedum Telephium, and a few specimens of Osmunda regalis.

On the shore between Barr point and Port William, we observed many of the maritime plants already noticed, besides Ranunculus hirsutus, a creeping variety of Ranunculus Flammula, Malva moschata, Scutellaria minor, Bartsia viscosa, Jasione montana, a common plant in all this district. We in vain looked for Erodium maritimum, and Solanum nigrum, which I picked several years ago on this shore. Leaving Port William, our route lay by Monreith Bay to Carleton, and thence to Glasserton and Whithorn. Want of time prevented us from visiting Burrow Head, as we intended, and thus we failed to get Artemisia maritima, which is abundant on the shore in that quarter. At Glasserton we saw Aquilegia vulgaris, and near Whithorn, Carex filiformis, Epilobium parviflorum, Fragaria elatior, Genista tinctoria, Hypericum maculatum (a species in many respects like H. dubium, and differing chiefly in the form of its sepals), Ononis antiquorum or spinosa, Ulex nanus, Veronica Anagallis, and Verbascum Thapsus. We also gathered some enormous specimens of Agaricus campestris and Georgii, some being 12 inches in diameter.

August 16th.—This day our walk was by the shore to Crugleton, Rigg Bay, Galloway House and Garlieston. The shore here furnished us with specimens of Crithmum maritimum, Genista tinctoria, Glaucium luteum, Linaria vulgaris, Aster Tripolium, Statice rariflora, often mistaken for S. Limonium, Hippophaë rhamnoides in plantations; in marshy places Hippuris vulgaris, Littorella lacustris, Chara hispida and flexilis, Bidens cernua, Scirpus lacustris and Scutellaria galericulata grew. On the sides of ditches Scolopendrium vulgare was abundant, and Hypericum maculatum and Lepidium Smithii lined all the road-sides.

The walk from Garlieston to Wigton, by Kirmadrine and Kirkinna did not furnish many new specimens. Hieracium umbellatum, and Lamium album, were met with. On the road between Wigton and Newton-Stewart we found Mentha rotundifolia and Ornithopus perpusillus.

August 17.—Crossing the bridge over the Cree at Newton-Stewart, we now entered Kircudbrightshire, and commenced to notice all the plants of the county with the view of completing its Flora. Following the banks of the Cree we reached Creetown, where granitic rocks appear and are quarried, and then walked by the shore to Carslooth castle, Cardonness, Gatehouse, Crumston castle and Kircudbright. The shores presented many of the plants previously noticed in Wigtonshire, such as Crambe maritima, Crithmum maritimum, Erythræa linarifolia, Glaucium luteum, Genista tinctoria, &c.; besides these, we noticed, Bromus mollis var. nanus, Juncus obtusiflorus, Calamintha Clinopodium, Campanula latifolia, Cardamine sylvatica, Pulicaria dysenterica, Silybum marianum, Solanum Dulcamara, Carduus acanthoides near the granite quarries where granite meets the greywacke, and Convolvulus sepium. The white and pink varieties of the last named plant, along with Epilobium hirsutum, Lathyrus sylvestris, Vicia sylvatica, and Linaria vulgaris in full flower, lined the shores near Carslooth, and presented a display of colours, than which nothing could be more beautiful and striking.

Near Carslooth, Lysimachia vulgaris grows in considerable quantity, and Ononis antiquorum is found on the shore near Ravenshaugh, along with gigantic specimens of Pimpinella Saxifraga. At Cardonness castle Lithospermum officinale and Inula Helenium occur; and Myrrhis odorata was picked near Kircudbright.

August 18th.—This day the shores near Kircudbright and St. Mary's Isle were visited, and we were rewarded with specimens of Allium arenarium and vineale, Statice rariflora and Limonium, Geranium pratense, Dipsacus sylvestris, Salicornia herbacea, Chenopodium maritimum, Habenaria viridis, and Rubus suberectus. We then proceeded to Balmae, and were kindly entertained by General Irving, an enthusiastic botanist, who accompanied us in our rambles, and pointed out many interesting plants. Under his guidance we gathered Ervum tetraspermum in small quantities on the shore, Acorus Calamus growing in a pond at Balmae, having been taken from a native station in Kircudbrightshire which has since been drained, Nymphæa alba, Acer campestre, Anthemis arvensis, and Aquilegia vulgaris.

Most of the party being anxious to get to Dumfries, I had not an opportunity of examining the neighbourhood of Balmae and Kircudbright at the time so thoroughly as I could have wished. In the course of a week afterwards, however, I again paid a visit to General Irving, and added a number of rare plants to my collection; among these I may notice, Pulicaria dysenterica, Carex paniculata, Thlaspi arvense, Potamogeton acutifolius, Artemisia maritima, Carduus heterophyllus, Epipactis latifolia, Juncus obtusiflorus, Polygonum Bistorta, Stachys Betonica, Doronicum Pardalianches, Scrophularia vernalis, Hippophaë rhamnoides, Euphorbia Cyparissias and Mentha rotundifolia (probably naturalized,) Botrychium Lunaria, and Ophioglossum vulgatum. At St. Mary's Isle there are numerous rare species, many of which, however, appear to have been introduced, such as Spiræa salicifolia, Lathyrus latifolius, Verbascum nigrum, Campanula Trachelium, Geranium phæum, Gnaphalium margaritaceum, Althæa officinalis, and Staphylea pinnata.

On the shores on the opposite side of Kircudbright Bay, and near Borgue and the Ross, I gathered Mentha rubra and viridis, Astragalus glycyphyllus, Lithospermum officinale, Triticum caninum, Arum maculatum, Œnanthe fistulosa, Artemisia maritima, Sanguisorba officinalis, Cladium Mariscus in marshes at Culraven, Gymnadenia albida and Ulmus suberosa.

Near Kirkudbright, and on the banks of the Dee at Tongueland, I found Ruppia maritima and Serratula tinctoria in profusion, Galium boreale, Calamintha Clinopodium, Origanum vulgare, Epilobum angustifolium, Thalictrum minus, Chelidonium majus, Polygonum Bistorta, Cotyledon Umbilicus, Geranium lucidum, sanguineum and pratense, Rubus saxatilis, Trollius europæus. To many of the stations on the Dee I was kindly conducted by the Rev. Mr. Williamson.

Returning from this digression to our party.—We proceeded from Balmae to Mulloch Bay, and thence to Dundrennan Abbey, Auchencairn, and Dalbeaty. Sium angustifolium, Carlina vulgaris, and a few other common plants were all that we observed.

August 19th.—From Dalbeaty we directed our course over a moorland country to Southwick, and thence to Southerness or Sauterness Point, Arbigland, Kirkbean, Carse Bay, New Abbey and Dumfries. The most productive part of our journey this day was in the neighbourhood of Southwick, and on the sandy shores and rocks near Sauterness. In fields near Southwick we picked with no small delight Anagallis cærulea in profusion, displaying its beautiful blue blossoms fully expanded, and associated with specimens of Anagallis arvensis, having remarkably large flowers, also Trifolium arvense, and Medicago sativa. The latter plant is cultivated by Mr. Stewart of Southwick, and he imported the seeds from abroad. To this some may perhaps be disposed to attribute the appearance of the blue Anagallis in the neighbourhood. Mr. Stewart has evidently done much to improve the agriculture of the district, and we were particularly struck with the excellent farm arrangements on his estate.

On moors near Southwick, we found Vaccinium Oxycoccos, Carex pauciflora, Scutellaria minor, Utricularia minor, Carlina vulgaris six or seven miles from the sea, Hypericum elodes, Drosera longifolia, and Alsine rubra. Near Sauterness Point where grey sandstone, some shale, coal, and limestone occur, we met with Anchusa sempervirens, Convolvulus arvensis and sepium, Eryngium maritimum, Hieracium umbellatum and inuloides, Atriplex rosea, Carex remota, Knautia arvensis (only seen in this place during the trip), Lychnis Githago, Lycopsis arvensis, Lysimachia vulgaris, Malva moschata, Ononis antiquorum, Ornithopus perpusillus, Ranunculus sceleratus, Rubus cæsius and suberectus, and Vicia gracilis.

Near Kirkbean and the Carse, Senecio viscosus was found, while Ononis antiquorum and Sanguisorba officinalis were observed on the banks of the Nith near Dumfries.

At Dumfries our party broke up, after twelve days of most pleasant botanizing. I remained for several days in the neighbourhood of Dumfries, and examined more fully the Flora of the district. Among the plants which I added to my collection, I may notice, Potamogeton pusillus, rufescens, heterophyllus, and perfoliatus, Lysimachia vulgaris, and Eriophorum pubescens or latifolium, near Maxwelltown Loch, Lobelia Dortmanna, Cerastium arvense, Pilularia globulifera and Typha latifolia at Lincluden, and T. angustifolia at Lochmaben, Cicuta virosa, Polygonum minus, Andromeda polifolia, Drosera anglica, Carex sylvatica, irrigua and lævigata, Symphytum officinale, Lepidium campestre, a rare plant in Galloway, Callitriche platycarpa, Nasturtium terrestre, Lolium temulentum or poisonous Darnel,* and Holcus lanatus, in a viviparous state. On Criffel, the highest hill near Dumfries, I gathered a few subalpine species, as Polypodium Phegopteris, Lycopodium Selago, selaginoides and alpinum, Vaccinium Vitis-Idæa, Allosorus crispus and Empetrum nigrum. The hill consists of dry granite rocks which are not much disintegrated, and, as frequently happens in such cases, is comparatively unproductive. Moreover, it does not attain a sufficient elevation for alpine species.

Such are a few hurried details of a botanical trip to a very interesting district of Scotland, which has not been as yet thoroughly examined. I trust that the remarks I have made will have the effect of inducing other botanists to visit these counties; and I am satisfied if they do so, that they will be amply rewarded.

* This plant existed in considerable quantities in a barley-field. Of late a case of poisoning caused by it has been recorded. The symptoms produced were somnolency, convulsive tremor, and coldness of the extremities. M. Ruspini says, that the adulterated flour may be detected by digesting in alcohol, which, when *Lolium* is present, assumes a characteristic green tint.

Dr. Balfour then exhibited a dried specimen of the leaves and flowers of the Green Heart tree, which he had received from Dr. W. H. Campbell of Demerara. This tree has long been known to merchants as furnishing a valuable timber, which is used by carpenters and ship-builders. The plant itself, however, is not known to botanists, and the specimens sent by Dr. Campbell are not in such a state as to allow a perfect determination of the genus and species. The plant undoubtedly belongs to the natural order Lauraceæ. The Perianth appears to be eight-cleft, hairy inside, with an unequal limb; the stamens sixteen, in two rows, with thick filaments, the anthers opening by four hinged valves; the fruit one-celled and one-seeded.

Professor Graham has named the plant Bebeeru febrifuga; but Sir W. J. Hooker does not think that we have sufficient materials for ascertaining whether the plant is a new genus or not. The bark of the plant is used as a febrifuge in Guiana under the name of Bebeeru bark; and Dr. Douglas Maclagan has used it as a tonic and antiperiodic in this country. He has procured two alkaline substances from it, called Bebeerine and Sipeerine, and has published his analysis in the Transactions of the Royal Society of Edinburgh. Specimens of the bark, wood, and fruit were also exhibited.

13*th March*, 1844,—*The* President *in the Chair.*

The following were admitted members of the Society:—Mr. Wm. Crichton, Rev. John Graham, Mr. William Bankier, Mr. John Miller.

The following papers were read.

XLIX.—*On the Minimum Rate of Annual Premiums for Insurance of Select Lives from Twenty to Sixty, and on the value of Annual Additions to Insurances at those Ages.* By William Spens, Esq.

1. The subject I have proposed for your consideration to-night cannot certainly be deemed of little importance; on a matter on which it may be safely affirmed that a great portion of the thinking community is practically concerned, it is undoubtedly desirable for them to ascertain their real position, and if there be any truth in the allegation that the subject is mystified by the pamphlets and advertisements of the Insurance Offices in their endeavours to prove their superiority over one another, there can be no better cure for this than a satisfactory solution of the questions here proposed for discussion.

2. In the course of the remarks which I shall offer you, I may be considered to pass too hurriedly over some points noticed, and to omit others which may have been expected to be alluded to, but I think it is desirable, in a paper like the present, to narrow the field for dis-

cussion in one night as much as possible. These other points may be taken up at some other opportunity. In this way I shall be more likely to attract your attention to each part of the subject. I have great confidence in the results I shall bring out; but I shall also show the observations on which they are founded, and there are many in the Society, who, from their acquaintance with such subjects, will be able to pronounce with authority an opinion upon them.

3. In discussing the question, much might be said in regard to the rate of interest to be assumed in the calculation; but, at present, our more immediate object is with the rate of mortality. And in stating that four per cent. has been adopted as the probable rate of improvement of money, from interest and profits after deducting expenses, I have no doubt that some will think this too favourable a supposition, while others will be of opinion that, under some circumstances, a greater accumulation may be expected: of course, the former will consider I should have stated the minimum rate of premium greater, and the others that I should have made it less.

In thus disposing of the question of interest, it is not intended to insinuate that it is one of minor importance, but only, I have more in view at present the consideration of the effect of the rate of mortality; and as a certain rate of interest must be taken in deducing the values, four per cent. has been adopted as I should think, in the opinion of many, at least as favourable a supposition of increase from interest and profit, less expenses, as may be expected by the generality of offices.

4. The observations published by the London Equitable Society are those best adapted for the deduction of our calculations. Much stress has been laid on the value of the tables, lately printed, of the experience of seventeen life offices, embracing 83,905 policies, and a rate of mortality has been presented with the printed tables, adjusted from the experience of 62,537 insurances. This adjusted table contains the experience of the London Equitable and London Amicable Societies; and as their experience extends over a much longer period than the other offices, although the number of insurances in these two was probably somewhat less than the half of the above 62,537, the deaths in them, which measure better the value of the experience, must have been much more than the half. The Equitable experience, again, is much more extensive than the Amicable, the former comprising upwards of 5,000 deaths, the latter about 1,800.

I have made a calculation of the values of the annuities (Table I. annexed) according to the probabilities of the duration of human life, deduced by Morgan from the experience of the Equitable, and find that these agree almost exactly with the values deduced from the table I have alluded to, founded on the 62,537 assurances.* The values brought

* For these values I refer to a series of tables calculated therefrom, and published by Mr. Jenkin Jones, actuary to the National Mercantile Life Assurance Society.

out from the Equitable experience are a little more. The near agreement of the two may be generally explained by the Amicable experience being on the one hand considerably more unfavourable, partly no doubt from the longer duration of the policies, and that of the other offices being doubtless considerably more favourable from the shorter duration of the policies, and of course the greater benefit of selection. Upon the whole, the tables of the Equitable experience appear to offer as favourable a view of life as can be anticipated in the experience of any office, and from the number of the policies, and length of time over which they extend, are better adapted for the solution of such questions as the present, than the tables of experience of the seventeen offices.

5. Referring then again to the Equitable experience, on the assumption that lives are better when they first enter into the society, that is, that persons, say of the age of 50, who have been thirty years in the society cannot be expected to be so good lives as those entering at 50, and of course then select lives, it will be obvious that the values of annuities deduced from their general experience will at young ages be stated too high, and, in a society of such long existence as the Equitable, at old ages too low, while they will be correct somewhere about the middle ages. This will be readily seen when it is considered that in the calculation of the values of annuities on young lives, they will derive the benefit of a continued influx of select lives at older ages, while the values of the old lives will be deteriorated by their being mixed up in the calculation with lives which, from their long duration in the society, will have lost much or all the benefit of selection.

6. With the view, no doubt, towards such calculations as I have made, most useful tables are given in the tables of experience of the seventeen offices, namely, tables H, showing the results of the Equitable experience for separate classes. These show the probabilities of living one year at all the older ages of the following number of lives admitted.

Table H 1, on 7,259 lives admitted,	from	25 to 34 inclusive.	Deaths	1,203
2, — 6,270	—	35 - 44	—	1,597
3, — 3,436	—	45 - 54	—	1,301
4, — 1,317	—	55 - 64	—	685
18,282				4,786

The ages at which the above total admissions took place were as follows, and I have placed opposite different ages the numbers exposed to the risk of mortality at each age, so as to enable a better estimate to be formed of the value of the observations :—

Extracts from

TABLE H 1.			TABLE H 2.			TABLE H 3.			TABLE H 4.		
Age	Ad-mitted.	Exposed to risk.	Age	Ad-mitted.	Exposed to risk.	Age	Ad-mitted.	Exposed to risk.	Age	Ad-mitted.	Exposed to risk.
25	643	642·5	35	743	742·5	45	470	469·5	55	204	204
26	615	1,230·5	36	728	1,453	46	437	895·5	56	210	409
27	683	1,823·5	37	735	2,120	47	429	1,278·5	57	161	549
28	732	2,401	38	659	2,655	48	370	1,569·5	58	140	660·5
29	783	3,002	39	668	3,160	49	389	1,868·5	59	154	780
30	762	3,546	40	615	3,568	50	321	2,079·5	60	118	836
31	785	4,077	41	561	3,903	51	293	2,219·5	61	91	867·5
32	780	4,580	42	541	4,206·5	52	263	2,315	62	91	895
33	726	4,976·5	43	525	4,475	53	240	2,379·5	63	88	912
34	750	5,386	44	495	4,689	55	224	2,453	64	60	909
	7,259			6,270			3,436			1,317	
35	...	5,029	45	...	4,413·5	55	...	2,291·5	65	...	849·5
40	...	3,464·5	50	...	3,149·5	60	...	1,587·5	70	...	529
45	...	2,413·5	55	...	2,127	65	...	1,030·5	75	...	282·5
50	...	1,578	60	...	1,380	70	...	568	80	...	102
60	...	513	65	...	814	75	...	285·5			
70	...	106	70	...	405	80	...	109			
80	...	2	80	...	46						

7. From the probabilities of living one year given in these tables H, without any adjustment, I have calculated the values of annuities at four per cent. as follows :—

FROM TABLE H 1.		FROM TABLE H 2.		FROM TABLE H 3.		FROM TABLE H 4.	
Ages.	Values.	Ages.	Values.	Ages.	Values.	Ages	Values.
25	17·75	35	16·22	45	14·12	55	11.50
26	17·58	36	15·94	46	13·41	56	11·14
27	17·37	37	15·72	47	13·75	57	10·87
28	17·19	38	15·52	48	13·08	58	10·50
29	17·01	39	15·31	49	12·80	59	10·07
30	16·76	40	15·15	50	12·48	60	9·80
31	16·55	41	14·94	51	12·20	61	9·38
32	16·32	42	14·70	52	11·95	62	9·03
33	16·08	43	14·44	53	11·71	63	8·71
34	15·87	44	14·16	54	11·39	64	8·31
35	15·64	45	13·88	55	11·06		

It is quite clear that in each of these tables the values at the top should be too great, and the values at the bottom too low, and that somewhere between the two the values should be correct. I consider the mediums in the respective columns may be stated as the ages, 29, 38, 48, and 57.

It is also clear, that the value at age 35, should be between the values stated opposite that age in the two first columns; in 45, between the values stated opposite 45, in columns 2 and 3; and 55, in the same way, between the values in columns 3 and 4. It is also necessary that the difference between the values at one age, and the next age, should be less than in the general table: this may be readily perceived must be the case, as where the annuities increase from the point of agreement towards the younger ages, less sums must be added to the separate class values, to make them lower than the others; and where they decrease towards the advanced ages, less sums must be subtracted to make the values in the separate classes greater.

Table II. has been made out, having all these points in view, but it was found impossible to make it harmonise entirely with them all. The chief difference appears to be in my being obliged to state the values from 39 to 45, almost in accordance with the values stated above, in column H 2. They ought of course, looking only to that, to be stated higher; but had this been done, 45 in H 2, would have been made about equal to 45 in H 3; and the regulation of the lessening of the differences would have been interfered with. It may be that the values alluded to in H 2, are accidentally higher; but the numbers of observations on lives and deaths from which they are deduced, are rather considerable, and perhaps the observations are correct, in leading us to the conclusion that lives selected about these ages are little better than lives selected a few years earlier which have arrived at these ages. It will be observed that Table II. has been extended back to age 20, which I thought could be very safely done by observation of the differences at the higher ages, and in Table I.

8. From Table II, Table III. is deduced of the minimum annual Premiums for Life Insurance, on the assumption that by means of interest and profit, less expenses, money is accumulated at 4 per cent.

9. In regard to the annual values of annual or periodical additions, I shall restrict myself to the values according to the systems stated below at ages 20, 30, 40, 50, and 60, and for reasons to be afterwards noticed, shall make the calculations according to the Carlisle Tables. The rate of interest assumed is as before, four per cent.

1st. Annual values of simple additions of One Pound, made every year, that is, One Pound if the party survive one year, and another Pound if he survive another year, and so on.

Ages	20	30	40	50	60
Values	·350	·409	·475	·549	·616

2d. Annual values of additions of 1 per cent. according to the system of the London Equitable, declared, say every seven years; that is supposing additions at the rate of 1 per cent., 7 per cent. at the end of seven years, other 14 per cent. at the end of the next seven years, at the end of the next seven, 21 per cent. more, and so on.

AGES	20	30	40	50	60
VALUES	1·013	1·028	·998	·908	·756

In this mode of division the values are much affected by the intervals at which the allocations are made; thus, supposing them to be made quinquennially, at age 40, the annual value will be 1·408; if sexennially, 1·169; and if decennially, ·691.

In the above two cases, greater or less rates of additions will be simple proportions of the above.

3d. Annual values of additions accumulated, say septennially, and with a provision that no addition shall be paid if the party die within five years. In this case, the different rates of addition are not simple proportions of one another, and I have therefore stated the values of additions at the rates of 1, 1½ and 2 per cent.

AGES.	VALUES OF ADDITIONS.		
	1 ₩ cent.	1½ ₩ cent.	2 ₩ cent.
20	·413	·677	·992
30	·466	·758	1·084
40	·523	·832	1·180
50	·585	·916	1·277
60	·621	·958	1·316

10. I have stated the above annual values of additions, according to the Carlisle Tables, partly because for the most part I had some time ago calculated them according to these tables, and further, because I am satisfied that the values thus brought out must be very nearly the true ones. Indeed it will be seen from the small difference between the values at the ages ten years different, that any such correction on the rate of mortality as might be made, could to a very small extent affect the results.

11. Assuming that we have now made a near approximation to the true premium, and the true values of annual additions, these afford the best means for testing the fairness of modes of allocations of bonus additions.

12. Under one system of assurance, a definite premium is fixed for a definite guaranteed sum, the rate of premium being stated at such sum as may be expected to yield a profit to the assurers in lieu of their guarantee. Under the other system, parties associate together to assure one another, and it has been generally thought desirable to provide against any extraordinary mortality, or unprofitableness of money, and to give the utmost confidence in such Society, that the rates should be, and should be considered by the public to be, such as will undoubtedly yield a surplus. Such are the two general systems on which assurance by proprietory offices and by mutual societies

is founded. Modifications of the latter system have been now very generally introduced by the proprietory offices charging higher premiums, and allowing a share—I must in fairness say a large share—of profits combined with guarantee.

13. It is thus seen generally how the surplus from which the bonus additions are allocated arises; and there will not be much wonder at the contrariety of opinion in regard to its division, when the following modes of division, although diametrically opposed to each other will be found to be both perfect in theory. The first is the case of a party who wishes to lay out £25 a-year in assurance, receiving the largest possible amount. The office approaching perfection, says, We will give you a policy of £1000 in the mean time, but in the course of a few years we shall have ascertained exactly what sum such a premium at your age will yield, and your policy will be increased accordingly. The second is the case of a party of the same age who goes to the same office, and states, I wish to secure a definite sum of £1000 to be paid at my death, I know I must pay more than is necessary just now, but I understand in a few years you expect to ascertain exactly what the proper premium should be, and you can then return me the difference paid, and reduce the premium for the future.

It is ascertained after five premiums have been paid by each, that £20 is the proper premium for £1000; both die a short time after this and the heirs of one receive £1,200, corresponding to £25 of premium; the heirs of the other receive £1,025, being the £1000 with return of over paid premiums. Both these modes are evidently quite fair in theory, looking to the respective views of parties in the transactions.

14. We must therefore look, in the first place, to the real or presumed intentions of parties in the original contract; and assuming that the surplus is intended to be applied in making annual or periodical additions, we may judge of the fairness of the rates and modes of addition, by adding their annual values to the true annual premiums as here approximated, and observing if the sums generally agree with the premiums charged. If the table of premiums here submitted do exhibit the minimum rate fairly apportioned at each age, giving effect to the rate of mortality which may be anticipated, and the proper rate of accumulation of money from interest and profits, less expenses, I think it will be readily conceded, that under ordinary circumstances, if the sums of these premiums and the annual values of the additions considerably exceed the premiums charged, then it must be fairly presumed that the additions are too great, and if too great, must cause unfairness to the new members, or those of the old who remain longest in the office. If again, the sums are at some ages considerably less, and at others considerably more, then an unfair advantage must be

presumed to be given on the one side, and a corresponding injustice committed on the other.

15. As an illustration of what I have been saying, I will cite the bonus additions of a Scottish office. It would be absurd to deny that their coincidence with the test of fairness proposed, is greatly owing to accident. We find that, adding the premiums in Table II. annexed, to the annual values of additions, at the rate of 1½ per cent. (Article 9, 3d mode,) as made by that Society, the sums are very nearly the same as the premiums charged by them, thus—

	AGE 20	AGE 30	AGE 40	AGE 50	AGE 60
Premiums per Table III, for £100.	1·383	1·753	2·368	3·474	5·320
Annual Value of additions of 1½ ℔ cent.	·677	·758	·832	·916	·958
Sums.	2·060	2·511	3·200	4·390	6·278
Premiums charged by Office alluded to.	2·075	2·554	3·275	4·413	6·266
Differences. . . .	+ ·015	+ ·043	+ ·075	+ ·023	— ·012

I have stated that I have myself great confidence in the table of premiums I have given, and the values of the annual additions; and undoubtedly if the premiums and values I have stated be correct, additions of no considerably greater value than have been given by the above office can be expected to be maintained by any office, that does not charge higher premiums or make more than 4 per cent. from its interest and profits, less expenses. Certainly in the early stage of an office, the large number of recently selected lives will tend to make the proportion of surplus greater at first. And if some extraordinary profit has been acquired, and a large reserve of surplus be made, there may perhaps be little further objection to the declaration of the full addition resulting from the calculations, though not likely to be continued, than the disappointment a reduction will cause. There is, however, great competition among offices; and although probably there is very little danger now, in the improved information on the subject, that the security of an office will be endangered by charging too low premiums for definite sums, it is desirable that the public should not, by the expectation of unreasonable additions, tempt any office to force its surplus to maintain them.

16. I will only add, that I trust no one will suppose I am prepared to advocate the minimum table of premium here given as a sufficient one for an office to adopt; indeed, it is clear, that supposing it is correct, an addition must be made by an office assuring to make profit; and I have already stated, that it is generally considered proper that the premiums of a Mutual Society should be such as will undoubtedly yield a surplus.

Table I.— *Values of Annuities at Four per cent, calculated from Morgan's Table of Probabilities deduced from the Equitable experience.*

Ages.	Values.	Ages.	Values.	Ages.	Values.	Ages.	Values.	Ages.	Values.
20	18·493	36	15·941	52	11·947	68	7·008	84	2·697
21	18·375	37	15·738	53	11·644	69	6·711	85	2·547
22	18·248	38	15·531	54	11·342	70	6·425	86	2·401
23	18·116	39	15·323	55	11·034	71	6·138	87	2·254
24	17·978	40	15·111	56	10·719	72	5·852	88	2·145
25	17·835	41	14·890	57	10·405	73	5·567	99	2·203
26	17·691	42	14·663	58	10·096	74	5·286	90	1·877
27	17·540	43	14·426	59	9·787	75	5·014	91	1·670
28	17·384	44	14·180	60	9·485	76	4·750	92	1·431
29	17·221	45	13·926	61	9·144	77	4·477	93	1·171
30	17·051	46	13·669	62	8·881	78	4·201	94	·827
31	16·879	47	13·401	63	8·568	79	3·924	95	·530
32	16·699	48	13·125	64	8·252	80	3·641	96	·240
33	16·516	49	12·841	65	7·930	81	3·367		
34	16·329	50	12·548	66	7·616	82	3·111		
35	16·139	51	12·248	67	7·310	83	2·872		

Table II.*— *Values of Annuities for Select Lives at Four per cent.*

Ages.	Values.	Ages.	Values.	Ages.	Values.	Ages.	Values.
20	18·12	30	16·86	40	15·09	50	12·66
21	18·01	31	16·71	41	14·88	51	12·39
22	17·90	32	16·55	42	14·66	52	12·12
23	17·79	33	16·39	43	14·43	53	11·85
24	17·67	34	16·22	44	14·20	54	11·58
25	17·55	35	16·05	45	13·96	55	11·30
26	17·42	36	15·87	46	13·71	56	11·02
27	17·29	37	15·69	47	13·45	57	10·74
28	17·15	38	15·49	48	13·19	58	10·46
29	17·01	39	15·29	49	12·93	59	10·18
						60	9·91

* The Insurances on female lives are comparatively so few that these values may be considered as for select *male* lives.

Table III.—*Annual Premiums for Assurance of £100 on Select Lives, Assuming Money to be improved at Four per cent., deduced from the preceding Table.*

Ages.	Premiums.	Ages.	Premiums.	Ages.	Premiums.	Ages	Premiums.
20	1·383	30	1·753	40	2·368	50	3·474
21	1·414	31	1·800	41	2·451	51	3·622
22	1·445	32	1·851	42	2·540	52	3·776
23	1·475	33	1·904	43	2·634	53	3·936
24	1·510	34	1·961	44	2·732	54	4·103
25	1·544	35	2·018	45	2·838	55	4·284
26	1·582	36	2·081	46	2·952	56	4·473
27	1·621	37	2·145	47	3·074	57	4·672
28	1·663	38	2·218	48	3·201	58	4·880
29	1·706	39	2·292	49	3·332	59	5·098
						60	5.320

L.—*On the White or Opaque Serum of the Blood.* By Andrew Buchanan, M. D., *Professor of the Institutes of Medicine in the University of Glasgow.*

It is well known to all who have been in the habit of examining the characters of the blood, that the serum which separates from it, instead of being transparent and of a yellow colour as we usually find it, is sometimes opaque and turbid, white as if milk had been diffused through it, or otherwise discoloured. Such serum is usually spoken of as white or milky serum. My present intention is to submit to the Society a few observations as to the causes in which this remarkable appearance of the serum of the blood originates.

It has been affirmed, that the blood itself is sometimes of a milky colour as it issues from the veins, or exhibits white streaks diffused through its dark-red substance. That this latter appearance is sometimes observable within the blood-vessels of live animals, more especially in the vicinity of the heart, and that it is occasioned by the chyle mingling but not yet incorporated with the blood, we have the testimony of various physiologists, as of Pecquet, who by tracing the white fluid to its origin, was led to the discovery of the two great trunks by which the lymphatic vessels communicate with the blood-vessels. In human blood flowing from the veins, I have never seen either white streaks or diffuse whiteness. I have indeed heard of such appearances being observed, but I am satisfied that they must be of very rare occurrence from my having looked for them so often in vain in the circumstances in which, as is shown below, they were most likely to have presented themselves. It appears to me, therefore, probable, that the indefinite expressions "white" or "milky blood," employed by Haller, and by many other writers before and since, must refer chiefly to the white state of the serum. This is certainly the meaning of some of the authors quoted by Haller, as of Tulpius, who conceived the white matter in the serum to be absorbed milk, and warns his patient against that beverage in time to come. Haller himself, however, takes no notice of this colour of the serum, and many of his expressions obviously imply a belief that the whiteness was an attribute of the whole mass of blood.* The only appearance, so far as I have ever seen, which could justify the application of such epithets to the blood, is that observed in inflammatory blood, which, when just about to coagulate, becomes whitish or bluish upon the surface. But this affords no solution of the difficulty as to the words of Haller, who expressly states that he omits all consideration of such blood.† We are therefore unwillingly compelled to recollect, that the same great physiologist, after a laborious examination of the arguments on both sides, declares that there is little or no difference in appearance between arterial and venous blood; and to conclude that the observations then made as to the colour of the blood were not worthy of implicit reliance.

Hewson introduced a more accurate mode of speaking of these phenomena, by referring the whiteness to the serum, and not to the general mass of blood. Hewson, also, first minutely described this condition of the serum, and analysed the circumstances on which it appeared to him to depend. He rejects the opinion, which was prevalent previous to his time, that the white colour was owing to unassimilated chyle circulating in the blood vessels. He ascribes it, on the contrary, to fat absorbed from the adipose tissue, which he supposes to be taken up more rapidly than the wants of the system require, and, therefore, to accumulate in the blood vessels. He further regards the phenomenon as generally connected with a state of disease; as with plethora, or a stoppage of natural evacuations. Such has been the authority of the name of Hewson, that both these opinions have been taught in the schools of physic ever since his time, and are generally received by the most eminent physicians of the present day. John Hunter stands almost alone in rejecting Hewson's doctrine, that the whiteness of the serum is owing to absorbed fat, "which," he says, "is certainly not the case; for it is not the same in all cases:" by which I understand him to mean, that the characters of white serum are not sufficiently uniform to warrant the supposition, that the colour is always occasioned by the same substance. Hunter also rejects the opinion that the white colour is due to unassimilated chyle; "because, it does

* Nempe in vivis animalibus, chylum albo suo colore conspicuum, sæpe per vasa sanguinea oberrare, de vulnere fluere, aut in cor ipsum apertum de auricula effundi vidi. Tom. ii. p. 14, Element. Phys.

† Id. ibid.

not occur frequently enough" to be ascribed to that cause. He observed it most "frequently in the blood of breeding women," and therefore conceived it might have some connection with the pregnant state; but, as he observed it also in other females and in men, he seems to have been at a loss what to think of it, "for," says he, "so far as I have been able to observe, it can hardly be said to have any leading cause."* Professor Trail of Edinburgh, has given an excellent account of three cases of a "cream-yellow" state of the serum, apparently connected with inflammation of the kidneys or liver, and he proved the existence in this serum of a fixed oil, as Hewson had done before him. Dr. Trail also first directed attention to a kind of serum like water gruel, in which he could discover no oil. He rejects the idea of the whiteness of the serum proceeding from the food, for that, he says, would have been long since detected. He embraces Hewson's opinion, that it is a pathological phenomenon, and caused by the fat being absorbed "by a diseased action of the vessels."† Dr. Christison seems to regard "lactescent serum" as a symptom of incipient granular disease of the kidneys. Some eminent modern physicians look upon it as a part of the series of morbid changes in the fluids of the body which occur in diabetes. Dr. Williams, in his recently published "Principles of Medicine," enumerates milky serum among the diseases of the blood. He thinks it most probably occasioned by an increased absorption of fat, occurring during any rapid diminution of the bulk of the body. Last of all, to conclude this sketch of the prevailing opinions upon this subject, M. Lecanu, who is generally looked upon as the highest continental authority as to the constitution of the blood, enumerates various diseases, of which "milky blood" is an accompaniment; he ascribes it, like his predecessors, to an increase of the fatty matter, while he gives as an additional cause, a disappearance of the red globules of the blood.

My attention was particularly directed to this appearance of the serum in the year 1840, owing to the frequency with which it presented itself during some experiments I was then engaged in making on the constitution of the blood. I observed with Hunter, that it was of very common occurrence in the blood of young women, who desired to be bled, either because they were, or supposed themselves to be pregnant; and whom, if no circumstances forbade, it was the custom to gratify in their request. Now, as these young women were for the most part strong and lusty, and therefore likely to take their food well, I was in doubt whether to ascribe the whiteness of the serum to their peculiar state of body, or to the food which they had probably taken not long before. To resolve these doubts, the most direct mode was to have a person in sound health bled at different periods after a full meal, so as to observe the effects of digestion upon the blood. Accordingly, a strong healthy young man, to whom a good dinner was an equivalent for the loss of a

* On the Blood, 37—39. † Edinb. Med. and Surg. Journal, 1821 and 1823.

few ounces of blood, was easily prevailed upon to submit to the following regimen and treatment. He had no breakfast, and at four o'clock had for dinner one pound of beef-steak, half-a-pound of bread, sixteen liquid ounces of brown soup, and half-a-bottle of porter. Three ounces of blood were then taken from a vein in the arm at three different periods; the first time, half-an-hour after the meal; the second time, an hour and forty minutes after it; and the last time, next morning at eight o'clock, or sixteen hours after the meal, no food having been taken in the interval. The blood as it issued from the vein had the usual appearance, and the serum which separated from it was about the same in quantity each time. The first time the serum was whitish and turbid; the second time it was like whey; while the third time it was perfectly limpid. The crassamentum on the two first occasions exhibited nothing peculiar, while on the last it was covered with a transparent fibrinous crust beautifully interspersed with white dots, which led the medical friend, who assisted me in these investigations to compare it to a precious stone.

As it might be supposed that this young man's blood was white before he took dinner, the two following trials were made to obviate that objection.

A vigorous man of about 35 years of age, after fasting 19 hours, had for dinner, twenty ounces of beef-steak, sixteen liquid ounces of brown soup, and eight ounces of bread. He was bled immediately before his meal, and three times after it, two ounces of blood being taken away each time. The serum obtained from the first bleeding before the meal was perfectly limpid; the serum from the second bleeding, three hours and fifteen minutes after the meal, was turbid; the serum from the third bleeding, eight hours and fifteen minutes after the meal, was still thicker; while that from the last bleeding eighteen hours after the meal, was again quite limpid, although some supper had been eaten in the interval.

The young man first mentioned, after fasting eighteen hours, dined upon sixteen ounces of brown soup, four ounces of bread, eight ounces of potatoes, twenty ounces of beef-steak, and sixteen ounces of London porter, and fasted eighteen hours after the meal. He had blood taken from his arm four times to the extent of two ounces each time. The serum of the blood first taken, immediately before the meal, was of an amber yellow and quite transparent; the serum from the second bleeding, two hours and ten minutes after the meal, was turbid; the serum from the third bleeding, eight hours after the meal, was exactly of the colour of water gruel and quite opaque; the serum of the blood last taken, eighteen hours after the meal, was still turbid, its limpidity not having been, as after his usual fare, restored by an eighteen-hours' fast.

In neither of the two last cases did the blood, as it issued from the arm, present white streaks or any thing else unusual. The crassamentum of the blood drawn before the meal, was in both cases of the usual red colour on the surface, as also that drawn first after the meal in the last case; but in all the other instances it exhibited the same *pellucid fibrinous crust* already described, although not dotted in the same remarkable way. We can scarcely avoid the conclusion that this pellucid crust is connected with finished digestion, when we reflect that out of nine bleedings practised within eighteen hours after a very full meal, this crust was observed on every occasion, if we except those in which the blood was drawn within three hours and a quarter of the period of taking the meal.

These observations, the accuracy of which I have since had opportunities of confirming, appear to me to leave no doubt as to the origin of the white colour of the serum of the blood. When a healthy man is bled fasting, his blood yields serum of a transparent yellow colour, like light Sherry wine, varying in the depth of the yellow tint, but always perfectly clear. In about half-an-hour after taking food, the serum becomes turbid, the discolouration increases during several hours till it attains its maximum, after which the serum becomes again gradually clearer, till its limpidity is perfectly restored. The period at which the discolouration is greatest, and the length of time during which it continues, must depend mainly on the quantity of food taken, but also in some degree on its quality, as some kinds of food are digested more readily than others. It may however be stated, so far as the observations I have made enable me to judge, that after a full meal of different kinds of food, the discolouration is greatest about six or eight hours after the repast, and that probably somewhat more than an equal period elapses before the serum regains its limpidity. The differences of colour, which are considerable, probably depend on the different substances digested: and it is interesting in this point of view to remark, that the colour varies in the successive bleedings after the same meal, as if the different alimentary principles produced different kinds of discolouration, and entered the blood-vessels at different periods.

It may be inferred from the facts narrated above, that the food digested in the stomach and bowels is introduced into the system, and mingled with the blood in a crude or half assimilated state; and that it requires to undergo a second digestion within the blood-vessels before it is perfectly assimilated. It is a highly interesting inquiry by what means this second digestion in the blood-vessels is effected. The analogy of plants would indicate the lungs as being the principal agents, for we find the crude sap brought by the sap-vessels to the leaves or organs of respiration, converted by them into the *succus proprius* or true blood of the plant. The respiratory act in man is not confined to the lungs, but takes place in every part of the system to which the absorbed oxygen is carried by the arterial blood: but it is a confirmation of the view just suggested, that at no time do we feel the want of free air more severely than soon after a full meal. In all probability, however, the process of assimilation in the animal body is more complicated than in plants, and may require the co-operation of various organs.

It is at present a matter of doubt among physiologists whether the primary nutritious liquid prepared by the digestive organs, is introduced into the blood through the lacteals, or through the branches of the portal vein. It cannot, however, be doubted, that when the nutritious matter is first absorbed, it is in the liquid state. It is remarkable, therefore, that it should be found afterwards in the blood as a precipitate, or in the solid state. It may, however, be readily conceived how this effect will be produced, when we reflect, that the food is dissolved in the stomach by an acid liquid; which, if absorbed by the veins of the stomach, will, on mingling with the blood, be at once rendered alkaline, and will therefore let fall whatever substances its acidity enabled it to dissolve. This reasoning, however, is no longer applicable, if we suppose the white matter of the blood to be derived from the admixture with it, of the alkaline chyle. A different explanation was suggested to me by Dr. R. D. Thomson. He supposed that the white matter of the serum might be soluble in it at blood-heat, just as the urate of ammonia and other sediments which often appear in the urine upon cooling, are held in solution at the natural heat of the body. On trying the effect of artificial heat, we found that the serum became considerably clearer, but it was still opaque.

It may also be supposed, that the serum is capable of dissolving a certain quantity of white matter, but after being saturated, deposits any superfluous portion. In confirmation of this view, I may remark, that the relative quantity of serum and crassamentum has an effect on the tint of the serum. Two individuals who had dined upon gelatin, had each the serum opaline, at the end of the third hour after the meal: after six hours the opaline tint was merely somewhat deeper in the one case, while in the other the serum was as opaque as I ever saw it; but on comparing the quantity of serum obtained from the same measure of blood in these two cases, it was found to be more abundant by one half in the former case than in the latter.

If any additional evidence be required of the origin of the white colour of the serum of the blood, it may be derived from an experiment of Hewson, from which so acute a reasoner could certainly never have drawn any other than the right conclusion, had it been one of his first experiments; but it was not made till his mind was thoroughly blinded by his theory of *re-absorbed fat*, and he in consequence misinterpreted it. Hewson had found that geese had very commonly white serum, though their chyle was always transparent; and he therefore chose to make his experiment on them. "I therefore" says he, "took two of them that were very hungry, and feeding both of them with oats, one I killed four hours after, when I knew a part of the oats were undigested, and upon examining the blood, I found the serum whitish, and full of small globules; on its being suffered to stand a little time, the white part ascended to the surface like cream. The other was killed forty-eight hours after eating, when its stomach was found empty, and the serum of its blood quite transparent, and without any cream rising to the surface, or any appearance of small globules, when examined by the microscope." The obvious conclusion from this experiment seems to be, that the one goose was killed while the digestion in the blood-vessels was in progress ; but the second not till long after it was completed: whence the milkiness of the serum in the former case, and its transparency in the latter. But instead of drawing this inference, Hewson will have it, that "the whiteness of the serum was occasioned by the fat being re-absorbed faster that it was used, (from its place being supplied by the fresh chyle,) and thence was accumulated in the blood vessels, so as to give whiteness to the serum."

If these views be correct, it is clear that a milky state of the serum of the blood is a phenomenon of the healthy body, and cannot in itself be regarded as a symptom of disease. There are, nevertheless, certain circumstances in which this appearance may serve to indicate the existence of disease, as when it continues during a longer period than according to the laws of health it ought to do. A case is mentioned above, in which, after eighteen-hours fasting, the serum of the blood was still loaded with white particles. The only inference that could be drawn from this fact, was, that the individual had taken a more than usually large quantity of food, and that the digestion in the blood-vessels was protracted in proportion. Perhaps it would not be warrantable to deduce any other inference, even were the milkiness to continue for twenty-four or thirty-six hours after a full meal. But when this milkiness continues for several days, although the appetite is gone and no fresh supply of food taken, it then becomes probable that the digestion in the blood-vessels is no longer going on, as in the healthy state; being like all other functions of the body, subject to retardation and derangement from the condition of the organs by which it is performed. Thus Morgagni found the serum white in the blood of two patients labouring under fevers ; of which he describes the one as malignant and attended with much danger, and the other as verging to malignity. In the former, the whiteness was observed in blood taken by the three last of four venesections which were required ; and in the latter, in blood taken on the third, and again on the fifth day of the disease.* Hewson states on the authority of a contemporary, that "a publican, of about thirty-five years of age, and corpulent, had been subject to a bleeding at the nose, to the piles, and to such profuse sweats in the night, as to be frequently obliged to change his shirt in the morning before he got out of bed, but that for some time past, his sweats had ceased. That on September the 23d, he was seized with a bleeding at his nose, which had been

* Morg. Epist. 49, Art. 22.

preceded by a pain in his head for two or three days; that his bleeding continued till he had lost about two pounds of blood, and then stopt; and that the serum of his blood was as white as milk. That at ten o'clock the same night, the hemorrhage returned, and he lost a considerable quantity; nevertheless, it was thought proper to take sixteen ounces of blood from his arm, during which evacuation he fainted, but his bleeding at the nose stopt. That the serum of this last blood was likewise very white. That on the 25th, in the morning, he again complained of a pain in his head, and about ten o'clock his nose began to bleed again; but the serum now appeared no whiter than whey. That he continued to lose blood during most part of the night, so that it was supposed he could not lose less than two or three pounds, the serum all this time being a little whitish, but so little, that the bottom of the vessel in which it stood could now be seen through it. That his bleeding returned repeatedly, till the third of October, when it entirely stopt, the serum having become more transparent towards the last."

Now, as it can scarcely be supposed that this man had gorged himself with food to such an extent before his illness, that his blood continued white for ten days afterwards, and as a spare diet would certainly be enjoined for so severe a complaint, we must conclude that the process of digestion in the blood-vessels was, in this case, preternaturally retarded, or in a state of disease. I have no doubt that hereafter, when the normal changes produced by digestion upon the blood are better understood, light may be thrown upon the nature of some diseases of nutrition, by administering certain articles of food, and examining the condition of the blood so many hours afterwards.

It is a fact of great interest, which has been established by various observers, that in diabetes, the serum of the blood often presents the milky opacity in great intensity. This is no more than might have been anticipated from the very large quantity of food taken by those labouring under that disease, which is often three or four times greater than is consumed by persons in health: for if the stomach act upon the food in the usual way, it cannot but happen that the blood will be loaded with white particles. Many pathologists indeed suppose, that a deranged digestion in the stomach is the fundamental part of diabetes. But the fact here mentioned seems to me, in some measure, inconsistent with that theory; for it shows that the food in diabetes undergoes the usual changes in the stomach, and is introduced into the blood in the usual form, so far as sensible characters enable us to judge. We may therefore be allowed to conjecture, that the essential derangement in diabetes is not a derangement of the primary digestion in the stomach, but of the secondary digestion in the blood-vessels, by which the unassimilated nutriment no longer undergoes the same series of changes as in the healthy state.

I conclude with a few remarks upon the physical and chemical characters of this variety of serum.

The colour of the serum is generally a milk-white; sometimes a cream-yellow; or a yellowish-brown, when the liquid bears a striking resemblance to thin oat-meal gruel. There is sometimes little discolouration, the serum merely losing its limpidity, and changing its hue so as to resemble a weak syrup made of coarse sugar.

In all the instances in which I have examined the liquid with the microscope, it showed a great number of solid granules mechanically suspended in it. They are less in size than the corpuscles of the blood, generally of irregular shape; but often spherical, and having the appearance of a nucleus in the centre, most probably from the refraction of light. These particles were as abundant in the syrup-like serum, as in the more opaque varieties; but they were less regular in shape, and seemed to be themselves translucent.

It sometimes happens, as has been observed both by Hewson and Hunter, that after the liquid has stood for some time, the white particles separate from it, and rise to the surface like cream. Hewson attempted to effect this separation by churning the serum, but without success. I accidentally hit upon a process by which the object is readily effected. It consists in saturating the liquid with common salt, which so much augments its specific gravity, that the opaque particles becoming relatively lighter, rise to the surface, either immediately, or soon after. This process has the further advantage of preserving the liquid. I still possess some of the original specimens obtained in November, 1840, on which the observations narrated above were made. One of them is the pure serum obtained before the meal. The other three contain white matter, which in two of them is still swimming in the liquid, nearly as when it first separated. In the third, again, the white matter, after swimming at the top for about two years, became denser, and fell to the bottom, where it has since remained. This precipitation was probably owing to the action of the air; as I have twice known it happen in a single night, when the air was not excluded by filling the phial completely and then firmly corking it. On examining with the microscope the concrete mass, after *creaming*, it is found to consist entirely of amorphous granules. It is obvious, indeed, that the white particles undergo a change in their mode of aggregation by the action of the salt, as they are readily separable by the filter after it but not at all before it.

The white matter separated by the filter is insoluble in water, and is thus easily purified from the salt with which it is mixed on the filtering paper, by steeping the latter in water, and then cautiously drawing off the water holding the salt in solution. Thus obtained it has the form of a fine white powder, which in two specimens in my possession bears a very close resemblance to wheaten flour. On holding a little of it in the flame of a spirit lamp upon a platinum spatula, it was immediately charred, and burned away almost completely. Dr. R. D. Thomson was kind enough to examine a specimen of it for me, but it was too minute in quantity to admit of a satisfactory analysis. He found it quite insoluble in ether and alcohol, while it dissolved in caustic potash. On boiling it in a solution of sugar of lead, it gave traces of black sulphuret. He concluded, therefore, that it contained no fixed oil, and consisted most probably of a *protein compound*, like albumen or fibrin.

A further opportunity was afforded of examining the chemical qualities of this kind of serum in some specimens obtained for illustration, with the prospect of submitting this subject to the consideration of the Society.

A man about thirty years of age, after fasting eighteen hours, dined upon twenty-four oz. of a pudding, consisting of two parts wheaten flour, and one part suet, seasoned with salt. Two oz. of blood taken before the meal, yielded a perfectly limpid serum. Seven ounces were taken three hours after the meal, and the same quantity six hours after it. The serum from the former was like syrup, but a little white: that from the latter was milk-white. The white matter in the latter was separated by Dr. Thomson, by means of salt and the filter, and appeared similar to the substance he had before examined. It contained no fixed oil. The other specimen of serum threw up its cream spontaneously. It left upon the filter only a trace of white matter, but a notable proportion of a fixed oil, which was easily demonstrated, by merely drying the filtering paper, and holding it between the eye and the light. It can scarcely be doubted that this oil was derived from the suet of the pudding, while the white proteinaceous substance most probably represented the gluten of the flour. Thus two of the three elements of which the food consisted, were found in the blood, but the starch, the most abundant of all, was sought for in vain.

Postcript. After the meeting of the Society on the evening of the 13th inst., it occurred to me as possible, that the starch might be converted by the organs of digestion into sugar, and be absorbed in that form into the blood. I accordingly procured some yeast next day, and treated with it the serum of the blood, which had been taken three hours after the meal, proceeding in the same way in which I am in the habit of examining diabetic urine. Fermentation ensued, and continued about forty-eight hours, the heat not having been regularly maintained. The serum from the blood of another individual who had used the same diet, but more sparingly, was treated in the same manner, when the same result ensued, only the gas was somewhat more abundant. But what struck me as more remarkable still, was, that the serum of the blood which had been taken from both these individuals after fasting, likewise fermented; although the quantity of gas obtained was much less than in the former instances. I found that the largest quantity of gas obtained in these experiments was about equal to that obtained by means of the same apparatus, from a solution of sugar in water, containing five grains to the ounce. Should farther observations confirm the idea here suggested of the existence of sugar in the blood as a normal product, it is obvious that a corresponding modification must be made of the prevailing theories of diabetes, according to which the production of sugar is regarded, as the essential derangement of action in which that disease consists.

27th March, 1844,—*The* President *in the Chair.*

A Report from the Botanical Section was read, stating that at their meeting on the 25th instant, Mr. Henry Craig had presented seeds from Pernambuco; and Mr. Balloch read a paper on two disputed species of fungi found on oak leaves—one of the species being known as oak spangles—which some authors consider to be caused by insects, but which he maintained to be true fungi. Drawings were exhibited illustrative of their high organization.

The following communication was then read.

LI.—*On the Impurity of some Drugs.* By Mr. David Murdoch.

1. Calamine, or Carbonate of Zinc.

As the calamine or impure carbonate of zinc sold in London, had been frequently examined by Dr. R. D. Thomson, and found always destitute of zinc, it became a matter of some interest to ascertain if the same remark applied to the calamine which occurs in commerce in Glasgow. Accordingly, at the request of Dr. Thomson, a specimen was subjected to analysis. The colour of this substance is well known to be a light red. When it is boiled with muriatic acid it effervesces slightly, and becomes perfectly white, the residue, consisting of a heavy white powder, which on being heated on charcoal before the blow-pipe, and then digested in acid, gives out the smell of sulphohydric acid; or when fused with carbonate of soda and digested in water, sulphate of soda is dissolved and carbonate of barytes remains unacted on. The main constituent of the commercial calamine is thus obviously sulphate of barytes. To ascertain if any zinc was contained in the red powder, the acid solution which was boiled upon it was mixed with a quantity of caustic ammonia in excess, which precipitated the peroxide of iron and alumina. This precipitate was filtered, and the ammoniacal liquid which passed through the filter was precipitated by oxalate of ammonia. The oxalate of lime was thrown on a filter, and the washings evaporated to dryness and heated to low redness in a platinum capsule. No residue was left, showing the absence of zinc and magnesia. 144 grains of calamine in one analysis gave of sulphate of barytes and some silica 128·05; peroxide of iron and alumina 11·55 grains; water 0·51 grains. And the results of two analyses were as follow:—

	I.	II.
Sulphate of barytes, . . .	88·74	89·77
Peroxide of iron and alumina, .	8·01	5·74
Carbonate of lime, . . .	2·90	4·40
Water, ...	0·35	0·35
	100·	100·26

Dr. Thomson having suggested that the mode in which this adulterated article was manufactured was by mixing together a portion of Armenian bole, chalk and sulphate of barytes, the next object was to examine Armenian bole for the purpose of comparison.

The following are the results of several analyses of this substance which is used extensively for colouring tooth-powders, &c. by druggists. The fourth analysis was made by my brother, Mr. James Murdoch:—

	I.	II.	III.	IV.
Silica, . .	50·15	47·31	—	49·38
Peroxide of iron,	22·69	32·96	31·	30·44
Alumina, . .	11·46			6·90
Lime, .	6·43	—	—	—
Water, .	—	—	—	7·04
Sulphate of lime,	—	—	—	8·30
Magnesia, .	—	—	—	1·98

To determine if any silica was contained in the sulphate of barytes of the adulterated calamine, the sulphate was fused with carbonate of soda, the fused mass washed with water until all the sulphate of soda was removed, and then the residue was digested in dilute muriatic acid—a portion of silica remained undissolved: the quantity was not determined. But it is obvious that the calamine contains all the substances existing in Armenian bole, and the conclusion is scarcely avoidable that the colour is caused by the presence of this body

2. Precipitated Sulphur.

This substance—also termed milk of sulphur, and washed sulphur—is properly prepared by boiling sulphur with lime or potash, precipitating the solution with muriatic acid, throwing the precipitated sulphur on a filter and washing it. If this form of sulphur were always prepared in this manner, no impurity would exist in it. But it has been observed that this article, in London at least, contains always above one-half its weight of impurity. To ascertain if this substance in Glasgow was equally impure 58·85 grains were ignited in a platinum capsule, and were found to lose 29· grains. This would make the composition of the sulphur = sulphur 49·27, and sulphate of lime 50·73. But as the gypsum was in crystals, it obviously contained its water of crystallization, which must therefore be calculated. The constituents of hydrous gypsum are:—Ca O = 3·5, SO_3 = 5, 2 HO = 2·25 = 10·75. The quantity of water belonging to the sulphate of lime found in the analysis will therefore be 13·42 per cent. The true constituents then are:—

Sulphate of lime, ...	50·73
Water of crystallization, . . .	13·42
Sulphur, ...	35·85
	100·

3. OXIDE OF ZINC.

This oxide generally effervesces on the addition of an acid, proving the presence of carbonate of zinc, or of the carbonate with which it has been precipitated. When to the solution of this oxide in muriatic acid an excess of caustic ammonia is added, some brownish red flocks of peroxide of iron remain undissolved, (containing perhaps a little alumina,) amounting to about 1½ per cent.

4. RED OXIDE OF IRON.

This oxide, as sold in the shops, has been examined by my brother, Mr. James Murdoch, and found to contain a small per centage of alumina.

5. TARTAR EMETIC.

This salt generally contains a small quantity of peroxide of iron.

NOTE.—The first person who published an account of the extraordinary mixture called calamine in the shops, was Mr. Brett, in 1837, in the British Annals of Medicine, vol. i. p. 485. He found, however, traces of lead and zinc in the specimen which he analyzed—a circumstance which has never occurred to me either before or since that period. It is possible, therefore, that the specimens may vary slightly. Sulphate of lead is a probable ingredient in minute quantities, but there is much reason to doubt if the manufacturer of this article is honest enough to supply his customers with even a trace of zinc. It is not a little remarkable that this adulterated article should have for so long a period been infesting every drug shop, to the utter exclusion, apparently, of the genuine article in England and Scotland, without any complaint from those who purchase it. Does this fact not prove that as calamine is used in the form of ointment, it is the lard which is the efficient application? Mr. George Schweitzer, of Brighton, first published an account of the impure milk of sulphur, in the British Annals of Medicine, in 1837, vol. i., p. 618., and showed that the sulphate of lime was introduced by substituting sulphuric acid for muriatic acid in the precipitation of the sulphur from its base. I may mention that this adulteration is easily detected by the microscope, the crystals of sulphate of lime being very apparent. It is not easy to discover any other method of excluding such adulterated articles from commerce, unless by the acquisition of a scientific knowledge of chemistry by the druggists of this country.—R. D. T.

10*th April,* 1844.—*The* President *in the Chair.*

It was agreed, on the recommendation of Council, that the office-bearers of sections shall in future be elected at the end instead of the beginning of the session. The Sectional Secretaries were therefore requested to summon their several sections for this purpose. It was also agreed that the next session should be opened with a conversational meeting, and a Committee was appointed to make arrangements for the meeting—Mr. Wm. Murray being Convener.

The following recommendation of Council was also agreed to:—viz., that a grant of money, not exceeding £5, be made from the funds of the Society, to a Committee for the purpose of investigating the Chemistry and Physiology of Digestion—the Committee to consist of Dr. Andrew Buchanan, Dr. Andrew Anderson, Mr. Stenhouse, Dr. R. D. Thomson; and Dr. John Findlay, Convener. The following minute of Council was submitted and approved of:—"That Mr. Liddell, Dr. Watt, and the Assistant Secretary, be appointed a Committee to prepare a Historical Account of the Origin and Progress of the Philosophical Society, to be prefixed to the first volume of the Proceedings of this Society."

The following paper was read at a conversational meeting at the Blind Asylum, on the 9th inst.

LII.—*On Printing for the Blind.* By John Alston, Esq.

The invention of printing in relief characters was among the earliest and most obvious methods employed for the instruction of the blind. By means of the sense of hearing alone, persons born blind, or who have been deprived of their sight, have frequently acquired a high degree of knowledge, and have distinguished themselves in literature and science. But in the education of the blind in early life, it was felt to be of the utmost importance to bring the sense of touch into play as an auxiliary to that of hearing; for in this way alone could we place the blind in circumstances fitted for carrying on the work of self-education after their leaving our charge. A great deal of ingenuity has been displayed in the formation of characters, which, in the estimation of their authors, were suitable for an alphabet for the blind. But, unfortunately for the attainment of the purposed end, it was found that the more arbitrary and complete the letters of the alphabet, the more impracticable did they become in the hands of the blind; and as for any possible interest in the matter on the part of the seeing, or any aid which they might render in teaching the blind to read, this never seemed to be thought as at all necessary to the success of the plan. The consequence was, that out of a long list of competing alphabets, every one more perplexing than another, both to the blind and the seeing, the one at last chosen as the most practicable of the whole, was that of the plain Roman letter.

It is not my intention to refer to the plans of teaching the blind to read which were in use before the invention of printing in raised letter. The merit of that invention belongs to M. Hauy of Paris, and dates as far back as 1784. His plans, or rather the plans of previous speculations on the subject of a general system of education for the blind, were matured by him into a practical form, and submitted to the Academy of Sciences, by which they were approved.

His desire was to see the sense of touch do for the blind, what the Abbe de E'pre had made manual signs do for the deaf and dumb; and a happy union of patient and benevolent enthusiasm led him to invent printing for the blind, a discovery which will hand down the name of Valentine Hauy with honour to posterity.

His plans were not, however, followed up in the large and benevolent spirit in which they were conceived. Institutions were erected for the reception of the blind, and efforts were made in all, to communicate oral instructions, and more recently to teach by a system of notation, invented by two blind persons, namely, Milne and M'Beth, in the Edinburgh Asylum, which consisted of an ingenious but cumbrous mode of forming letters by knots and loops on twine. But no efforts were made till a recent period to carry out the plan of printing books for the blind. A step in advance was at last taken by Mr. Jas. Gall, of Edinburgh, who produced the Gospel of St. John, and several elementary works, in an angular Roman character, about 1828. Mr. Gall deserves great credit for this benevolent enterprise in behalf of the blind, but the expense of his books was such, even had the character in which they were printed answered, as to preclude the poorer classes, for whom they were intended, from being benefited by them.

A little after this period, Mr. Lucas of Bristol brought out his Stenographic Alphabet, which involved too many difficulties both to the blind and the seeing, to be at all likely to serve the purpose in view. A somewhat similar plan was afterwards produced by Mr. J. H. Frier, which was equally objectionable amidst the variety of systems which were brought before the public. The Society of Arts for Scotland, Edinburgh, in 1832, offered their gold medal, value £20, for the best alphabet for the blind. Fifteen different competitors presented themselves. Of these fifteen plans, twelve were composed of arbitrary characters, or symbols, and three were modifications of the Roman character. These alphabets were submitted by the Society to the different Institutions for their consideration throughout the kingdom, in 1836; and it was at that period that my attention was first directed to the subject. We had adopted the alphabet of Mr. Gall, but did not realise the hopes we at first entertained of them.

It then occurred to me, that the best method proposed, was that of Dr. Fry of London, who recommended a light modification of the capital letter of the Roman alphabet. By communicating with the Society of Arts, I ascertained that neither Dr. Fry (now deceased), nor any other person, had tested his plan by experiment.

I now set about a series of experiments in Dr. Fry's letter, which I had cut for the purpose, but found they would not do, being too obtuse; but I had them modified successively, after putting them to the test of the children's fingers, till the whole underwent very material changes, which it is needless here to describe, but may be observed in the adaptation of the sharpness of the letters for hair strokes and other peculiarities suggested to me during a careful observation of the best method of meeting the wants and obviating the difficulties of my blind charges.

With my experimental knowledge thus acquired, I thought I might venture to recommend Dr. Fry's plan with such changes as had been suggested by these observations, to the Society of Arts, which I accordingly did on the 5th October, 1836; and the Society in May, 1837, reported in favour of Dr. Fry's alphabet, in preference to any arbitrary character, and most deservedly awarded the medal to his plan.

On the 26th October, 1836, I brought before the public at the annual examination of the blind, in the Trades' Hall, my first specimen of printing. By the exertions of the ladies who attended that meeting, and with the assistance from kindred institutions, and a grant from Her Majesty's Government, I was enabled to complete the great task of printing the whole Bible in December, 1840.

In May, 1837, after I had brought out my elementary books, I resolved to pay a visit to the different institutions. In this I was greatly encouraged by the friendly co-operation of the Rev. William Taylor of York, who had paid great attention to the subject, to whom the Society of Arts had submitted the competing alphabets, and who also reported on this subject to the British Association. I was also under obligations to another gentleman, namely, Charles Baker, Esq., the talented head master of the Doncaster Institution for the Deaf and Dumb, and the writer of the article "Blind," in the Penny Cyclopædia. Being encouraged by such competent judges, I visited York Institution, Norwich, London, Bristol, Liverpool, and I had the satisfaction of finding, that all the gentlemen connected with those institutions, with the exception of Liverpool, entered warmly into my plans.

At that time I only met with five persons who knew letters; on my second visit, soon after the introduction of our books, a considerable improvement was perceptible. Subsequently I visited the English institutions a third time, and found great numbers reading with ease and intelligence. There are now, I have reason to know, hundreds reading the books both in schools and in private families, and many are in possession of the whole Bible, and I have printed upwards of 14,000 vols. from 6d. up to 13s.

The importance of furnishing this interesting class of our fellow-creatures with the means of moral and intellectual improvement, appears in a striking light, when we consider the proportion generally which they bear to the seeing population.

We have, unfortunately, no statistics of their number in this country; but, in the kingdom of Belgium, a government census of the blind was made in 1835; the result of which showed, that there were 4117 blind, in a population of 4,154,922, establishing the ratio of one to 1009; of this number, 960 were blind from the effects of ophthalmia.

It is worthy of observation, that the same government, with a benevolent liberality deserving to be imitated by others, have enacted that every indigent blind or deaf and dumb person belonging to the country, shall be educated at the expense of the state. In the Prussian dominions in 1834, there were 9575 blind, for a population of 13,509,927, being one to 1410.

From a careful investigation by Mr. Zeune of Berlin, it appears that the number of persons affected with blindness, is less in the temperate latitudes, and increases either as we advance to the line or to the pole. In the one case, the reflection of the rays of the burning sun producing the same effects on the eyesight, as those from the snow covered plain on the other.

According to the calculation of Mr. Zeune, from imperfect data, in reference to the numbers of blind in different latitudes, Great Britain ought to have a population of 18,000 blind. It is melancholy, therefore, to reflect, that in this country there should only be accommodation for 800 in institutions where any provision is made for their instruction in mechanical arts, and for their moral and intelligent training.

NOTE.—The accompanying specimen exhibits the mode of printing and writing in use among the blind. By the latter method they are enabled to correspond with each other.

The following paper was then read.

LIII.—*On the supposed Influence of the Moon upon the Weather.* By WALTER CRUM, F.R.S., *Vice President.*

THERE is no more common belief, even among those who make accurate observations on other subjects, than that changes of the weather are more decided, and occur more frequently at changes of the moon than at any other period of the month. A similar influence is very generally ascribed to the full moon; and not a few look for changes at the commencement of every quarter.

I had abundant opportunity of observing the firmness with which this opinion is held by a class of men who are placed in circumstauces that may be thought the most favourable for testing its correctness. In December, 1820, I sailed in a Maltese vessel from Valletta to Marseilles, and took six weeks to perform what is usually done in ten days. I soon became desirous to gather opinions of the weather, and found them to be formed entirely on the phases of the moon. Every new quarter was to bring a favourable wind, and although we were repeatedly disappointed, the next quarter was still anxiously looked forward to for relief. During that voyage, my faith in the moon, if I ever had any, was thoroughly shaken, and I afterwards became desirous to procure facts which would enable me to form an accurate opinion on the subject. I was not a little pleased, therefore, to meet, in the following year, with a paper by Professor Olbers, of Bremen, " On the Influence of the Moon upon the Seasons;" confirming most satisfactorily the views I had formed upon slighter examination.

As on all subjects where uncertainty prevails, and where men are guided more by imagination than by fact, there is here the greatest variety of opinion. In some of our almanacks minute directions have long been given for predicting the weather for the succeeding half month, from the hour of the day or night at which the moon enters the first or the third quarter; and I know that they obtain very general credit, their antiquity forming an important argument in their favour. For instance, if we have new or full moon at midday, we may expect much rain in summer, and rain and snow in winter. If at midnight, the weather will be fair in summer, and fair and frosty in winter; and so on, for every two hours in the twenty-four. These predictions, or rather rules for predicting, we are assured, have stood the test of half a century; but if, as is said, they were drawn up by Dr. Samuel Clarke, from his own experience, they must have existed at least a hundred and twenty years.

I trust that the great prevalence of such impressions will excuse me with the Society for calling their attention to it; and if, to some of its members, the statements I have collected are already familiar, they may be reminded that it is through a Society like ours that error on such subjects may be expected to be removed from the public mind. There are, certainly, more dangerous errors, but it cannot be doubted that the habit of holding loose notions upon matters even of little importance, incapacitates for accurate thinking on those which are of greater consequence.

It may be desirable, in the first place, to take a glance at the early history of this belief. I have, therefore, selected a few of the more important of the facts brought together by the learning and industry of Bishop Horsley, and read by him to the Royal Society in 1774.

Aratus, an astronomer and physician, who lived in the time of Euclid, appears to have been the first to collect, in his book of prognostics, the notions of this kind that were prevalent in his day. That work, owing more, it is said, to the quality of the verse in which it is written, than to the interest taken in its statements, procured commentators in abundance among the Greeks and Romans. Pliny relates at great length the celestial signs; Germanicus translated them, and Virgil recommends them to the serious consideration of agriculturists. Aratus prognosticates the weather from a great variety of objects—from the heavenly bodies—from animals, planets, and terrestrial objects, but, from the moon's aspect in particular, he could predict the weather only from one quarter to another. These predictions were founded upon the indications which the moon gives of the existing state of the earth's atmosphere. Thus, he says, if the moon, on the 4th day, cast a shadow, the weather will be fine during the remainder of the first quarter—meaning, that the moon at that early stage, is a delicate test of the clearness of the atmosphere. Again, the bluntness of the horns in the new moon is a sign of approaching rain, for if the air were clear, they would be of their natural pointed shape. And after the half moon, the horns being then always blunted, other indications are given for predicting the weather till the full moon.

But the vulgar, says Dr. Horsley, soon began to consider those things as causes, which had been proposed to them only as signs. The manifest effect of the moon on the ocean, while the mechanical cause of it was unknown, was interpreted as an argument for her influence over all terrestrial things; and these notions were so consistent with the visionary philosophy of the times, that such men as Theophrastus and Varro, who should have been its opponents, ranged themselves on the side of the popular prejudice. Theophrastus says that the new moon is generally a time of bad weather; the light of the moon being wanting, and that changes of the weather generally fall on the new and full moon, and on the quadratures. Pliny had his eight critical days for changes of the weather, which were the days of new and full moon, the quadratures, and the four octagonals, or rather the nearest odd numbers to these days, viz. the 3d, 7th, 11th, and so on; for besides the influence of these periods, there was much of virtue in the odd numbers. And so great a man as Varro, as he is quoted by Pliny, was not ashamed to give this childish rule for predicting the weather for a month to come, from the appearance of the new moon. "If the upper part of it," he says, "be obscure the decline of the moon will bring rain; if the lower horn, the rain will happen before the full; and if the blackness be in the middle, we shall have rain at the time of the full moon." Theophrastus and Aratus taught their followers to remark the position of the horns at different times of the moon's age, whether they were erect, inclined or prone, and thence to take conjectures of approaching fair weather or tempest.

"On the whole," says Dr. Horsley, "I do not deny that the observant husbandman will find useful prognostics in the appearances of the moon, and the heavenly bodies in general, but they will be prognostics of no other kind than the sputtering of the oil in the industrious maiden's lamp, and the excrescences which gather round the wick. They will show the present state of the air however, and may thereby furnish conjectures for two or three days to come."

The subject has of late years occupied the attention of some of the most distinguished astronomers of Europe, and numerous observations have been made to ascertain the amount of influence exercised by the moon over our atmosphere. Every different position has been carefully investigated, and years of observation have yielded results adverse to the popular impression. A few of these I shall relate, not in the order of their publication, but by taking up each question separately.

1st. *Does a change of weather occur at changes of the moon, or on the days on which the moon enters a new quarter, more frequently than on other days of the month?*

Dr. Horsley registered, during two years, every considerable change of weather that took place, and arranged the results in tables, showing at the same time the day and hour at which the moon entered each of her quarters. During the first of these years sixty-nine decided changes were recorded, and twenty-two of them occurred on days corresponding to the quarters, or octants, which is just four more than their even proportion. But rejecting the changes which were reversed within the twenty-four hours, there remain, out of forty-six changes in all, only ten on the days of lunar influence, which are two less than belong to them on the even chance, for the days of syzygy, quadrature and octant $= 98$, and $365 : 98 = 46 : 12\frac{1}{3}$. Of these ten changes, only two coincided with a new moon; two also with a full moon, but they were reversed within twenty-four hours.

During the succeeding year, 1774, Dr. Horsley continued his register, omitting however September and November, these two months having been particularly changeable. Here thirty-nine changes occurred in ten months, of which fourteen were on the days specified, being four more than their equal share. Of these fourteen, only four fell on the day of a new moon, and none at all on the day of the full. If we take the latitude of three days before and three days after every quarter, which the popular idea allows, and thus increase the number of the influential days, more changes of the weather would of course occur on such days, but still only the proportion due to that increase of number.

I might here adduce the opposite results of Toaldo of Padua, obtained by computation from a course of fifty years' observations by the Marquis Poleni, and showing that many more changes occurred at the new and full moon, than at the first and last quarter; but they seem to be of no value, for it turns out that, *assuming* the moon's influence to be greatest at the change and the full, Toaldo spread these periods over three days, including the day before and the day after, and then compared the changes of weather that occurred on all the three days with those of the single days on which the quarters fell. Toaldo uses an extraordinary argument to enforce his conclusions. "Every one," he says, "is aware from his own experience, that the nails and hair grow much more quickly when cut during the increase of the moon than when cut during the wane."

In opposition to Toaldo, there are twenty-five years of observations of the different phases of the moon, by Pilgram of Vienna, which give as their result:—

58	Changes of weather	on the days of New moon.
63	—	on those of the Full moon.
63	—	at the Quarters.

The difference is no doubt occasioned by the difficulty of deciding what constitutes a change of weather in the sense understood by Pilgram. Were it otherwise these results would prove seven or eight per cent. fewer changes of the weather at the change of the moon than at any other period of the lunation—a conclusion at which no one has ever arrived and which is altogether improbable.

Olbers, the celebrated discoverer of Pallas and Vesta, declares that the experience of many years has convinced him that at least in the climate of Bremen the rules of Toaldo are utterly false. "We shall be convinced," he adds, "of the smallness of the moon's influence, if we reflect that weather of the most opposite kind occurs in different parts of the world at the same moment, and consequently with the same lunar phase. This is most readily observed during an eclipse when accounts of the weather arrrive from many different quarters. The remarks, for example, that were made during the solar eclipse of the 18th November, 1816, have been collected in this way, and furnish a singular mixture of good and bad weather spread on that day over a great part of Europe." Olbers quotes also the observations of Professor Brandes as furnishing results to the same effect.

2d. *Does the Moon Influence Rain?*

This question has been investigated by Schubler in a course of twenty-eight years' observations in different parts of Germany. His results were published in 1830, and they seem to show that rather more rain falls during the waxing moon than when it is waning; and also that a greater number of rainy days occur during the first half of the moon's course than during the last. But I do not trouble the Society with Schubler's tables. Being a mean result of mixed observations, they do not bear upon the question in hand; for, whatever change of weather took place at one change of the moon might be balanced by an opposite change at the next—the popular belief acknowledging equally a change from fair to foul and from foul to fair—I will only mention that he found five per cent. more rain to fall during the seven days when the moon was nearest to the earth, than when at the most distant part of its orbit. Schubler's results, as I have said, decide nothing as to changes of the moon producing changes of the weather; but they seem to show that some relation does exist between the moon and our atmosphere. They are affected, however, by too many foreign influences; and are summed up from observations too little capable of precision to entitle the deductions from them to rank among ascertained facts.

3d. *Does the moon influence the winds?*

The meteorological tables published in our monthly scientific journals, give the direction of the wind at a particular hour of each day. Such tables, indeed, differ materially when made up a few miles from each other; and they mark the slightest local breeze equally with the most generally prevailing wind. No very important conclusion can therefore be drawn from them; and yet we may expect, from the balancing of the various other causes of change, that if the phases of the moon influence at all the movements of the atmosphere, these movements will be perceptible in summing up the results of a series of years. If it cannot be perceived from such results that the winds change more decidedly at new moons than on the other days of the month, neither can it be noticed by an observer, whose only register is his memory; and it may reasonably be presumed, that changes in the other phenomena constituting weather, which are generally accompanied, if not regulated, by changes of the wind, are also incapable of being traced to lunar periods.

I have chosen, as most convenient for reduction, the register of the winds kept at Chiswick, near London, and published in the Philosophical Magazine. The state of the wind at one o'clock of each day is that which is noted. In order that the amount of change from one day to another may be stated in numbers, I have marked as 1 a change equal to one-eighth of the circle; as, from N.to N.E., or from S.W. to S. A change of two-eighths is marked 2; and the greatest change, viz. from N. to S., or from S.E. to N.W. marked 4—thus,

1838, Feb. 8, . .	S.W.			
9, . .	S.W. . .	0	Full moon
10, . .	N.E. . .	4	
11, . .	N. . .	1	
12, . .	N. . .	0	

An abstract is given below of tables drawn up in this manner from observations of six years.

TABLE SHOWING THE CHANGES OF WIND IN CONNECTION WITH THE MOON'S AGE.

	1838 12 Moons	1839 12 Moons.	1840 13 Moons.	1841 12 Moons.	1842 12 Moons.	1843 12 Moons.	Total in 73 Moons.	Sums of five days connected with each quarter.
1 ●	12	12	19	20	8	14	85	396
2	14	11	13	13	11	10	72	
3	12	15	19	17	14	14	91	
4	11	8	14	16	8	14	71	
7	16	13	15	16	13	11	84	
8	16	16	21	13	11	7	84	
9 ☽	16	15	16	16	14	10	87	442
10	16	14	12	23	19	12	96	
11	13	12	20	12	16	18	91	
12	11	6	13	12	9	14	65	
15	21	14	21	23	12	16	107	
16	13	15	20	16	14	17	95	
17 ○	8	15	16	14	20	21	94	447
18	13	11	13	10	10	14	71	
19	8	10	13	23	12	14	80	
20	11	19	16	18	11	24	99	
23	16	13	9	15	14	6	73	
24	6	18	16	18	8	18	84	
25 ☾	9	18	8	14	13	14	76	379
26	7	16	13	12	13	7	68	
27	13	9	15	12	11	18	78	
28	10	10	13	14	10	17	74	
31	11	7	18	11	8	9	64	
32	10	13	22	12	14	13	84	
							1973	
Average........................							82	
Do. of each year.............							13½	

Thus in 1838, on the 12 days of new moon, the amount of change, as compared with the previous 12 days, was equal to 12. On the second day of the moon it was 14. On the 12 days on which the first quarter fell, the changes were equal to 16. It here appears that the average changes for one day of the moon's age in each of the 73 moons is 82, and that 85 changes occurred on the 73 days of new moon, or 3 more than the average. But it also appears that on the days of full moon and of the first quarter, the changes are still more; and that all of them are exceeded by several of the intermediate days on which no lunar influence is supposed to be exerted. It will farther be remarked, that on the days of the new moon, the changes vary from from 8 in 1842, to 20 in 1841, and that in three of the years they are below the average of 13½. To account for the omission of certain days in the table, it is necessary to explain that as each quadrature had to be placed in the same line, and the number of days between the quadratures being unequal, blank days frequently occurred in the columns which had been marked the 5th and 6th, 13th and 14th, 21st and 22d, 29th and 30th days of the moon, and that these have been omitted for the purpose of shortening and simplifying the table.

4th. *Have tides been observed in the atmosphere?*

They must be assumed to exist by all who acknowledge the moon's influence upon the atmosphere, for scarcely in any other way can such influence be supposed to be exerted. An atmospheric tide, however, like that of the ocean, must twice every day have its ebb and flow—changes quite as great as those to which the effects in question are attributed; and yet we never hear of changes of weather being expected in correspondence with each of these atmospheric waves. But even the existence of any double diurnal oscillation produced in the atmosphere by the attraction of the sun and moon, has never yet been detected. It is altogether insensible to an ordinary barometer. Laplace reduced a great number of exact observations, and found the differences due to those attractions so minute and so variable as to leave him in doubt of their sensible existence. And Arago, to whom we are indebted for much information on this subject, after a minute detail of the observations of Flaugergues and Bouvard, arrives at essentially the same conclusion.

We have no ground, therefore, either from theory, or direct observation, for believing that the moon produces any change upon the weather; or, at least, it must be allowed, (to use the words of Dr. Olbers,) that its influence is so slight as to be lost among the infinite number of other causes and forces which destroy the equilibrium of our easily disturbed atmosphere, and therefore altogether insensible to ordinary observation.

The following communications were then made:—

LIV.—*On a Theoretical Rule for the Compression of Water.* By Daniel MacKain, M. Inst. C.E.

The extreme elasticity of air, when considered with reference both to the amount of force which we can apply to it, capable of producing important changes in its volume, without any great effort, and to the strength of the materials of which the instruments used for ascertaining its compressibility, are composed, have enabled philosophers to determine with considerable accuracy the ratio which obtains between the force applied and the resulting condensation of volume.

A considerable time ago it was believed that the compressibility of air was in proportion to the pressure applied; this was subsequently proved nearly 200 years ago, by Boyle, and also by Mariotte about 50 years afterwards; and this law of compression has since been known by the name of the latter. More recently Messrs. Dulong and Arago have confirmed the accuracy of the law of Mariotte, by experiments conducted to the range of no less than 27 atmospheres beyond the common atmospheric pressure.

By means of the barometer, the density of air is found to vary according to its mass superincumbent over any given point in the atmosphere, and the numerous experiments made with this instrument, have brought to such a degree of accuracy the barometrical measurements of parts of the earth's surface protruding into the air, as to vie with measurements of their heights made by trigonometrical instruments. These degrees of density are measured by a column of mercury, and consequently, the height of the column indicates the force of compression, and represents the height of the superincumbent mass of air.

The extent of compression which water undergoes, when subjected to force, has engaged the attention of men of science for some time back. In 1762, Mr. Canton found that the addition to, or subtraction from water, of a weight equivalent to that of the atmosphere, produced at the temperature of 60° a contraction or extension of rain water of 4 millionth parts of its bulk, and of sea water of 40 millionth parts, while in mercury it only amounted to 3 millionth parts: showing that the density of the fluid operated on materially affected the results. Thus, in the case of rain water, a force equal to a column of itself $33\frac{1}{3}$ feet in height produced a contraction of 46 millionth parts: of sea water, a column 32 feet in height produced a contraction of 40 millionth parts: and in mercury, a corresponding column of $2\frac{1}{2}$ feet produced 3 millionth parts of compression. Zimmerman, Professor at Brunswick, Professor Œrsted, of Copenhagen, the late Sir John Leslie, of Edinburgh, and Mr. Perkins, have made numerous experiments that establish the fact of compression ascertained by Mr. Canton, which, at the time his experiments were published, was at variance with the opinions universally entertained on this subject. With the usual haste which Sir John Leslie speculated on experimental results, he arrived at the conclusion "that the ocean may rest on a subaqueous bed of air," from the apparently greater degree of condensation which force can produce in air, in contrast with that which similar forces were supposed capable of producing on water.

The degree of compression of water, is, however, extremely small; and the force which it is necessary to apply to it, in order to produce any appreciable degree of diminution in volume, is so great in proportion to the limit of rigidity of the materials used in experimental apparatus, that there is much room for doubt, as to whether or not the indications heretofore recorded, be not compound measures of the elasticity of water, and of the materials of which the instruments have been formed.

It has occurred to me, that if the results of experiments were noted, in which great bulks of water were employed, but operated upon by slight forces, that a degree of compression might be ascertained, sufficient to remove much of the doubt that may at present be entertained as to the rigid accuracy of the experiments on which our ideas of the elasticity of water are at present based—further, that, in these experiments, should any analogy be discovered between the ascertained laws which govern the compression of air, and the comparative indications of compression of water—we may take the laws which repeated experiments have proved to govern the compression of air, as analogous rules for the compression of water; and, calculating from them, may compare the theoretical results which the laws would furnish, with similar conditions ascertained by experiment.

Following out this idea, it appears probable that the transmission of water and gas through long ranges of pipes, may, by the comparative forces required to propel given quantities through them, give an approximate rule for estimating their compressibility—for, if water were totally incompressible, there would undoubtedly be some difference between the quantities of air or gas transmitted through a pipe, and that of water by a corresponding force, through a similar pipe—the one would accumulate in density according to the force required for its propulsion; while the movement of the other would be like a bar of iron, influenced only by friction.

In the transmission of water through long ranges of pipes, it has been ascertained that the quantity discharged by a pipe of any given diameter and length, is inversely in proportion to the square root of the length—and directly proportional to the square root of the height of the column of water employed to propel it.

The comparatively recent adaptation of carburetted hydrogen gas, for the purpose of lighting towns, has required attention to the laws by which it is conveyed through pipes. Gas is usually forced through pipes, by employing a slight column of water, of a height sufficient to propel the required volume with the velocity required. Now, as already mentioned, the laws of compression of gases and air *have been exactly ascertained;* and it is thence evident, that even the slight compressing force usually employed for the transmission of gas, must produce an alteration in its bulk, at the place where the motion originates.

The most exact observations made as to the laws by which gas is conveyed through pipes, show that in like manner as water, the quantity which a pipe can discharge, is inversely proportional to the square root of the length of the pipe, and directly proportional to the square root of the force employed to propel it. As gas, after having been propelled through a range of pipe, and when escaping from its extremity into the air, will be only of the density due to the pressure of the atmosphere—the portion of it at the origin of the pipe, or, as is usual in practice, that in the gas-holder is not only of the density of the atmosphere, but is also of that further degree of compression due to the force applied for its propulsion through the pipes. In all experiments made with pressure-gages along various lengths of pipes, this extra degree of compression is found to diminish according to the square root of the length of the pipe, thus showing a gradual relaxation of compression, and a steady progression of current.

The ascertained laws of impulsion and of retardation of gas and water being thus exactly alike, it only now remains to ascertain their measure; and if these be found proportional to their density, there appears reason to believe, that water, under proportional forces, is as compressible as air.

I shall endeavour to support these views by the following facts, and deductions from them:—

As water is 825 times heavier than air, the velocity communicable to air contained in a pipe by the pressure of one vertical inch of water is equal to that of 825 vertical inches, or 68 feet of air; and if gases be referred to, as their specific gravity is usually compared with air, as 1, the height of a corresponding column of any gas is equal to 68 feet divided by the specific gravity of that gas; thus, one inch of water is equal to $\frac{68}{\cdot 560}$=122 feet of gas, specific gravity ·560.

In the Hydrodynamie of Bossuet, he states as the result of experiment, that an aperture of one inch in diameter, under the pressure of a column of water 10 feet in height, discharged 8,574 cubic inches, or 4·96 cubic feet of water per minute.

By an experiment made at the Leith Gas Works, a hole, one inch in diameter, under the pressure of one vertical inch of water, discharged 17·7 cubic feet of gas, specific gravity ·560, in the same time.

Now, comparing these discharges by the square roots of their respective impelling columns, we have

Water, Gas,

$\sqrt{10}$ feet : 4·96 :: $\sqrt{122}$ feet 17.33,

instead of as above, the actual discharge 17·70.

Again, Bossuet reports, that a hole 2 inches in diameter, with a pressure of 11 feet 8 inches and ten lines of water, discharged 13,021 cubic inches of water in 21 seconds, or at the rate of 25·52 cubic feet per minute.

It was also found at Leith, that a hole 2 inches in diameter, with a pressure of one inch of water discharged 69·5 cubic feet of gas, specific gravity ·560, per minute.

Reducing the fractions of Bossuet's pressure to decimals of a foot, and resolving the pressures into columns of the respective substances, we have the proportionate discharges due to these columns:—

Water, Gas,

as $\surd$ 11.736 feet : 2 : 2152 :: $\surd$ 122 : 69·41

cubic feet, which may be reckoned to be identical with the result brought out by experiment.

The Abbe Bossuet found by experiment, conducted with great care, that a pipe, 2 inches in diameter, 150 feet long, with the pressure of a column of water 2 feet in height, discharged 5·232 cubic inches, or 3·0278 cubic feet of water per minute.

I have been favoured by the results of two experiments made with pipes of 2 inches in diameter, and 150 feet long, which, with a pressure of one vertical inch of water, discharged 22·66 cubic feet of gas, sp. gr. 560, and with 2 inches of water 35.16 cubic feet.

In contrasting these experiments, it is to be remarked that the pipes are of the same diameter, and of the same length, consequently, the only correction necessary is that due to the variation in the height of their respective impelling columns—thus, as before, the experiment with one inch of water—

Water, cubic feet, Gas,

as $\surd$ 2 feet, 3·0278, so is $\surd$ 122 feet, 23·647,

the actual discharge with one inch being 22·66; and that of 2 inches of water—

Water, Gas,

as $\surd$ 2 : 3·0278, so is $\surd$ 244 feet to 33·443

cubic feet—the actual discharge as above having been 35·16.

In 1819 M. Gerard made various experiments with gas apparatus constructed for lighting the Hospital of St. Louis, at Paris, to ascertain the discharges of gas and air through pipes at the distances of 402½, 1233, and 2043 feet respectively from the gasometer,—the discharges of air with a pressure of 0·858 of an inch of water were 30·205, 18·150 and 13·237 cubic feet per minute.

Not having any direct experiments with water made under precisely the same conditions, I shall only apply the hydraulic formula of Dubuat, to show the similarity of discharges of that fluid under the same circumstances.

0·858 of an inch of water is equal to 58,334 feet of air—with this head the discharge of water by the same pipe, about the distances above stated, would be 36·206—21,598, and 14·015 cubic feet.

The close approximation of all these results will, I hope, be a sufficient warrant to me for having brought the subject nnder notice of the Society, with a view to provoke further inquiry; whether the calculations I have entered on, or the deductions drawn from them, be correct or not.

I shall now proceed to compare the rates of compression under this theory, with those indicated by experiment.

Air is found to be compressed into one half its bulk by the addition of a weight equal to that of the atmosphere, or the addition of a force equal to 28·330 feet of air. In the same proportions between gas and water indicated by the impelling and retarding forces in a long train of pipes, water should also be compressed into one half its bulk, by the addition of a force equivalent to a column of itself, 28·330 feet or 5·36 miles.

Professor Leslie estimates that it will be only compressed to this degree, at the depth of 93 miles.

It has already been mentioned that Mr. Canton had indications which represented the contraction of pure water as 46 million parts, and sea water as 40 million parts, by the addition of a force equal to the weight of the atmosphere. By the rule of compression followed in this paper, pure water would compress 11·65 millionth parts—and sea water 11·55 parts in a million, with the pressure due to an atmosphere of air.

Zimmerman arrived at the conclusion that sea water compresses $\frac{1}{340}$ part, when under the pressure of 1000 feet of its own body,—the present theory indicates that it would contract very nearly $\frac{12}{340}$ parts under the same pressure.

Professor Œrsted's apparatus, judging from the engraving in the transactions of the British Association, seems to have been incapable of measuring with accuracy the forces stated to have been used.

In 1826 Mr. Perkins laid before the Royal Society, a table of compression of water, derived from experiment, in which he states that of a column of 190 inches of water to have been for

			Parts.
10	atmospheres	...	0·176
100	do.	...	1·385
200	do.	...	2·395
500	do.	...	5·010
700	do.	...	6·961
1000	do.	...	8·855

while by the theory now advanced these compressions would have been

			Parts.
10	atmospheres	...	2·1
100	do-	...	20·0
200	do.	...	36·2
500	do.	...	70·4
700	do.	...	89·1
1000	do.	...	102·7

I cannot avoid calling the attention of the Society to a slight though rude corroboration of the theory now advanced—the belief of seamen in the greater density of water at great depths, than is generally admitted. They find a great difficulty in sounding in deep water, but with very heavy leads. From the increased weight of the leads required, and from the diminished effect on the hand when sounding, seamen are almost universally impressed with the idea that the loss of effect is produced by the increased density of the water.

An additional interest may be attached to the further investigation of this subject from the possible effect it may have on geological speculations. At the great depths of the ocean, and amid the profound stillness which reigns in these parts where the tides do not act, many substances of great specific gravity may float in the mass of waters, and thus be permitted to obey the slight but constant impulses of elective attraction—producing crystals, and leading to the formation of crystallized rocks. But I shall not enter into any speculations on this subject.

I shall only add, that if water be compressible to the degree I have now advanced, and the substances now stated were incompressible, bricks will float at a depth of 28,330 feet; granite at 56,600 feet, or 10 miles; and cast-iron at 200,000 feet, or 39 miles.

Professor Gordon read a paper illustrating the application of the *method of least squares* to the reduction of "Provis's* *experiments on the flow of water through small pipes*, and to a mathematical formula, of simple application, for calculating the *diameter of pipes*, the *head, quantity of water*, and *length of pipe* being given. After the reading of the paper, Mr. John Wilson stated, that he had been required to place a pipe of eight feet in length horizontally, so that under a constant head or pressure of ten feet of water it should discharge neither more nor less than 100 imperial gallons of water per minute, and not being able to derive any information from such engineers as he had consulted, he had been under the necessity of arriving at the proper result by numerous experiments. He considered that it would be a fair test of the formula proposed if Professor Gordon would calculate the true diameter of the pipe, from the data given. It was accordingly agreed that Professor Gordon and Mr. Wilson should compare their theoretical and experimental results at next meeting.

24*th April*, 1844,—*The* PRESIDENT *in the Chair.*

The secretaries of the different sections reported that meetings had been held for the election of sectional office-bearers for 1844–45; the

* Trans. Inst. of Civ. Eng. Vol. II.

former Chairman and Secretaries (page 177) being again elected, with the exception of the Physical, in which Mr. MacKain was chosen secretary.

The following report from the Statistical section was presented and approved.

Friday, 12*th April*, 1844,—Mr. Murray *in the Chair.*

Mr. Murray of Monkland Iron Works was elected Chairman, and Dr. Watt Secretary for the following year.

Dr. Watt read the following paper on the defective state of the Registers of Births, Marriages, and Deaths in Scotland. The following gentlemen were appointed a standing Committee to watch over any measure that may be brought into Parliament for the improvement of these Registers, and to take such steps as may be found necessary to urge it forward.—Mr. John Wilson, *Convener.*

Committee:—Mr. John Wilson of Auchineaden; Mr. Smith of Deanston; Mr. Murray of Monkland Iron Works; Mr. Walter Crum of Thornliebank; Dr. Andrew Buchanan, Glasgow College; Dr. R. D. Thomson, Glasgow College; Mr. Leadbetter of Ericht Bank; Mr. William Bankier, of Cullibheag, Provost of Calton; Mr. Keddie, Glasgow; Dr. Watt, City Statist.

As it is of great importance to the poorer classes of society in many matters connected with their welfare, and also to the more wealthy classes, in the settlement and conveying of property, as well as in some of their domestic arrangements, that the Registers of Marriages, Births, and Deaths should be accurately kept, it is surprising that these Registers for Scotland should still remain in the very imperfect state they now are, and that no legislative measure should yet have been obtained for their improvement.

A knowledge of the laws of mortality is intimately connected with, and illustrative of the social condition of the people. Hitherto this knowledge in Scotland has been based on imperfect data, owing to these Registers being very incomplete; so much so, that in the solution of some of the most important questions affecting the sanatory condition of towns, the philanthropist and the scientific inquirer, in their endeavours to ameliorate those evils which appear to be so fatal to life, in various towns and districts of this division of the Empire, have to depend more on the speculative views of men, than on the knowledge of incontrovertible facts. In the greater part of Scotland no Registers of deaths are kept at all; and in those towns or districts in which they are kept, the mode of Registration is very imperfect: for although reliance may be placed on the accuracy with which the ages at death, and a few of the more easily discriminated diseases, such as eruptive fevers, hooping-cough, and some others, are recorded, yet the general mode of Registration is so incomplete, especially in regard to the localities in which the deaths take place, the trades and professions of the parties who die, as well as in the great majority of the diseases which cause death, that no satisfactory information can be obtained from them as to the effects produced on human life by the vicissitudes of the climate, in connection with the trades and professions of the people, and the existing state of the different localities of large towns.

The Registers of Births in this country are so very incomplete that they are of no value to the statist for any calculations relative to the duration of life, or for tracing in a satisfactory and decisive manner the propinquity of families.

The law of Scotland, as it now stands, relative to the proclamations of marriages, when properly adhered to, is well adapted for enabling us to ascertain the amount of resident *regular* marriages in each parish, yet the system of recording these marriages is very defective. The ages at which the parties marry cannot be obtained from them, and many other particulars which would enable us to arrive at correct conclusions as to the proportionate amount of marriages which take place among the various classes of the community, and other important particulars, are altogether omitted in these records.

As it is well known that the greatness of a country depends on the general well-being of its population, it must ever be one of the first objects of study on the part of an enlightened nation, to introduce such laws as may tend to improve the social condition of the people; and as the science of vital statistics has for its object the discovery of those laws by which nature regulates the amount of disease and death, under every variety of circumstances, as well as "the discovery of those truths which tend to the comfort and happiness of the people," it is to be hoped that the energy with which this study has lately been followed out, especially in England, will soon cause it to hold a still higher place among the great branches of human knowledge than it has hitherto done, and that the benefits of a better system for the Registration of Births, Marriages, and Deaths, will speedily be extended to Scotland.

Several attempts have been made to introduce a legislative measure for the improvement of these Registers in Scotland without success, owing, in the last instance, as we have been informed, to the opposition offered to it by such as considered their own interests affected by the measure proposed, and to the apparent indifference of those who, it was understood, ought to have been more alive to the importance of the measure. Within these few years a number of petitions have been presented to Government with the view of urging forward a legislative measure of this description for Scotland, similar to that now in force for England. It has been thought, however, that should a revisal of the Poor Law of this country take place, which is shortly expected, it will be the proper time to introduce a bill into Parliament for the improvement of these Registers. It would be well, therefore, that the Statistical Section of this Society should appoint a Committee to watch over the measure, and to take such steps as may be necessary to forward it.

Mr. Gourlie communicated some observations on the natural history of several species of British zoophytes, illustrated with specimens; and Mr. Stenhouse drew the attention of the Society to specimens of manna which he had obtained from different sea-weeds, in accordance with the observations of Vauquelin and Gaultier de Claubry. Mr. Stenhouse stated that from the *Laminaria saccharina* he had extracted as much as twelve-and-a-half per cent. of manna by means of alcohol.

The following communication was read.

LV.—*Test of Formula for Discharge of Water through Pipes.*—By L. D. B. GORDON, *Regius Professor of Civil Engineering and Mechanics.*

THE formula which best represents the results of Provis's experiments, as well as those of Hagen,* and the experiments of Dubuat, that could be employed, as also of Couplet, is based upon the formula originally proposed by Woltmann,† in which the *height due to the resistance* in the pipes is made proportional to a certain power deduced from experiments. The exponent 1·75 was deduced by Woltmann, and is also the *most probable* exponent according to the experiments above mentioned.

It was advisable, after assuming this exponent, first to determine the *head due to the velocity of discharge*, and as this is expressed by a member containing the second power of the velocity as factor, but quite independent of the length of the pipe, only those experiments could be used *in which pipes of the same diameter were used but of several different lengths,* as in the experiments of Provis and Hagen, and certain of those, for small pipes, of Dubuat; and some of Couplet's for pipes of even twelve to eighteen inches diameter.

The equation of condition chosen then, was:

$$h = \left(\frac{c}{0{\cdot}82}\right)^2 \frac{1}{2g} + p\,l\,c^{1{\cdot}75}$$

In which h = the head, due to the resistance in the pipes, c = the

* Detailed in Poggendorff, vol. 36.

† Beitrage zur Hydraulischen Architectur. Bd. I. 151.

velocity of discharge, $p =$ *a constant factor*, and $l =$ the length of the pipe. 0·82 is the co-efficient of contraction of water at entering the pipe, and $g = 32{\cdot}2$ feet. The experiments above named were employed to deduce p by the method of least squares. It is found that p is very nearly inversely proportional to the diameter of the pipe, and therefore $k = p\,r$, is introduced. The formula may then be written:—

$$h = 0{\cdot}23\, c^2 + k \frac{l}{r} c^{1{\cdot}75}$$

In Provis's experiments,	$r = 0{\cdot}75 - {\cdot}01 = {\cdot}74$	$p = 0{\cdot}0474$	$\therefore k = {\cdot}0035$
Hagen, . .	$r = 0{\cdot}117 - {\cdot}01 = {\cdot}107$	$p = 0{\cdot}0447$	$\therefore k = {\cdot}00478$
Dubuat, 3 . .	$r = 0{\cdot}089 - {\cdot}01 = {\cdot}079$	$p = {\cdot}0619$	$\therefore k = {\cdot}00488$
Couplet, 3 . .	$r = 6{\cdot}45 - {\cdot}01 = 6{\cdot}44$	$p = {\cdot}00103$	$\therefore k = {\cdot}00622$

·01 inch is taken from the radius to allow for the film of water adhering to the pipe. These are a selection from the fifteen sets of experiments used, and which prove that k is not constant, but varies with the circumstances of the pipe as to *the actual velocity through it and the amount of curvature* or bending. Provis's experiments give the same co-efficient to the third or fourth decimal places with those of Dubuat and Bossut in analogous circumstances, of a small velocity of discharge and straight pipe. Hagen's agree excellently with one another. In these *the velocity was great* and the diameter *very small;* so that internal *interfering* motions in the water in the pipe were recognisable. Dubuat's experiments in analogous circumstances correspond well with those of Hagen. The co-efficient deduced from Couplet's experiments rises as the degree of sinuosity designated in the original tables. The pipe from which the result above given was found is designated as *much bent,* but the velocity through it was small. Upon these grounds I proposed that for practice we might employ the co-efficient ·00315 in very regular pipes; for gentle curves this rises to ·005; and for very sharp curves might even amount to ·01, because in practice there not only occur the *curves* or *bends,* but contractions from deposits and from collecting air in these bendings.

The formula for straight pipes would then stand thus:—

$$h = {\cdot}023\, c^2 + 0{\cdot}003 \frac{l}{r} c^{1{\cdot}75}$$

and as in ordinary practice the first member (on the right hand) is generally small whilst the sinuosities are numerous, though gentle or accidental interferences occur, it appeared that this might be reduced to—

$$h = {\cdot}005 \frac{l}{r} c^{1{\cdot}75}$$

as a simple formula of approximation.

Mr. Wilson at last meeting proposed that the above formula should be tested by application to the following question: What should be the diameter of a pipe of eight feet in length, laid horizontally, in order that under a constant head or pressure of ten feet of water it may discharge neither more nor less than 100 imperial gallons per minute?

In the case proposed by Mr. Wilson to test the formula here arrived at, the velocity through the pipe must evidently be very considerable, and hence it was thought best to choose the constant $k = \cdot006$.

Now, if Q = the quantity of water $= \frac{r^2 \varpi}{144} c$, by substituting this in the last we have $c = \frac{144\,Q}{r^2 \varpi}$ and hence $h = \cdot006 \frac{l}{r} + \left(\frac{144\,Q}{r^2 \varpi}\right)^{1\cdot75}$

$\therefore h = \frac{4\cdot84\,l}{r^{\frac{19}{4}}} Q^{\frac{7}{4}} = \frac{4\cdot84\,l}{r^{4\cdot75}} Q^{1\cdot75}$ and from this latter we have $r^{\frac{19}{4}}$ $= \frac{4\cdot84\,l}{h} Q^{\frac{7}{4}}$ a formula very convenient for calculation by logarithms, as appears by the following actual working of the question proposed to test the formula:—

$Q =$ 100 gallons ·266 cubic feet *per second.*
$l =$ 8 feet.
$h =$ 10 feet.

Log. ·2666 =	$\bar{1}$·4259677
	7
$\frac{7}{4}$ power = 4	5.9817739
Log. 98967 = —	$\bar{2}$·9954434
Log. 4·84 × 8 = 38·72 =	1·5879353
	0·5833787
Log. 10 =	1·0000000
	$\bar{1}$·5833787
	4
$\frac{4}{19}$ root = 19	$\bar{2}$·3335148
Log. ·81713 =	$\bar{1}$·9122902

Then ·81713 + ·01 = ·827 = r, therefore
·827 × 2 = 1·654 is the diameter of the pipe according to the formula.

According to the subjoined report of the engineer who made the experiments for Mr. Wilson, the pipe found experimentally to fulfil the required conditions was one inch and $\frac{11}{16}$ = 1·6875

Formula gives, . . .	1·6544
Difference, . . .	0·0331

In a second case, where all other data remain the same, save that the discharge is limited to 80 gallons per minute, the pipe fitted experimentally was . . 1·5625 inches diameter.
By formula it should be . . 1·5315

Difference, 0.0310

In both cases about $\frac{1}{32}$ of an inch less by the formula than was actually found necessary.

Now, to show how perfectly justifiable the adoption of the higher coefficient ·006, is in this case, if we determine the discharge using the complete formula, viz.—

$$h - {\cdot}023\, c^2 = {\cdot}003 \frac{8{\cdot}07 l}{r^{4{\cdot}75}} Q^{1{\cdot}75}$$

We can by the above deduction of the diameter $d = 1{\cdot}6544$ determine $c = 16{\cdot}5$ nearly

$$h - {\cdot}023\, c^2 = 3{\cdot}74$$

$$r^{4{\cdot}75} = \frac{2{\cdot}42 l}{h} Q^{1{\cdot}75} \quad \text{from which we have}$$

$$r = {\cdot}86 + 01 = {\cdot}87 = d \; = \; 1{\cdot}74$$

	1·74
Pipe	1·6875
Difference,	0·0525

Formula in *excess* of experiment.

A mean between the two results of the formulas is 1.69, a result which would naturally have been chosen, had the case been to be put in practice at this moment.

Interim Report by the Subscriber, PETER M'QUISTEN, *Civil Engineer in Glasgow, relative to agreement between the Proprietors of Househill, and Messrs.* JOHN WILSON & SONS.

Glasgow, 3d April, 1837.

GENTLEMEN,—I have your letter of the 27th March, 1837, with excerpt of agreement between Proprietors of Househill and Messrs. John Wilson & Sons, dated 16th March, 1837, and I beg leave to report, that a lead pipe eight feet long, laid horizontal, and having a pressure of water upon it of ten feet perpendicular, will vent a discharge exactly one hundred imperial gallons of water per minute, by making the pipe one inch and eleven sixteenth parts of an inch in diameter.

I have also to report, that a lead pipe eight feet long, laid horizontal, and having a pressure of water upon it of ten feet perpendicular, will vent or discharge exactly eighty imperial gallons of water per minute, by making the pipe one inch and nine sixteenth parts of an inch in diameter.

I am, Gentlemen,

Your very obed. Servant,

(Signed) PETER M'QUISTEN.

To ROBERT WYLIE, Esq., Writer, Paisley,
Agent for the Proprietors of Househill,
and ALEXANDER GIBSON, Esq. Writer, Paisley,
Agent for Messrs. JOHN WILSON & SONS.

Mr. Cockey exhibited and described a model of Smart's steam-boat paddle float.

Mr. James Johnston then gave a description of a seven horse power boiler, constructed according to his patent plan, so as to prevent the formation of deposits on the interior of the boiler.

The boiler, properly speaking, consists of two parts, viz.:—The furnace, and the body of the boiler.

The furnace is placed on the front and outside of the boiler; the sides and roof of it are made of a double casing of sheet iron, the iron of each casing being one-eighth part of an inch thick; the water space between the casings is a quarter of an inch wide, and the casings are bolted to one another every two-and-a-half inches. The sides of the furnace are perpendicular—the roof is sloped like the roof of a house, each half of the roof being set at an angle of forty-five degrees on the sides of the furnace. The water space of the furnace has three openings or communications with the body of the boiler; of these communications there is one at the lower part of each side of the furnace, the other one is at the ridge of the roof of the furnace. In consequence of this arrangement, there is constantly a powerful current of water circulating up the sides, and over and along the roof of the furnace; it is this current of water which prevents the deposits of salt and other substances.

The body of the boiler is divided into seven chambers or flues, which communicate at one end with the furnace; at the other end they are each provided with a separate chimney, which communicates with the funnel. Each of those chambers measures from top to bottom two feet nine inches, from furnace to chimney two feet, width two inches. Between each chamber there is a water space of a quarter of an inch in width. The latter are the spaces in which the ascending current of water is created in consequence of the action of the heat which is supplied from the seven chambers.

At each side, in the body of the boiler, there is a large water space through which the currents of water descend. The fire is not allowed to act on those descending water spaces, for, if the fire were allowed to do so, the velocity of the current would be checked, and the boiler injured.

The entrances from the seven chambers into the chimneys, are at the bottom, or lower part of the chambers. In consequence of this a saving of fuel is effected, as the products of combustion are by this means retained in the chambers until all the available heat has been absorbed by the water.

Note.—This boiler is at present working on board the "Alert" steamer, at the West Quay, Greenock.

The following paper was read at the meeting of the Botanical Section, 29th April.

LVII. *Notice of Excursions made from Glasgow with Botanical Pupils during the Summer Session of* 1843. By J. H. Balfour, M.D. F.R.S.E. *Regius Professor of Botany.*

You are all aware that I am in the habit of making excursions every week with my pupils during the months of May, June, and July; and by so doing I am satisfied that I tend to promote a taste for the science of botany. Nothing adds so much to the interest and pleasure of a botanical course as practical demonstrations in the fields; and it is pleasing at the end of each season to recal the adventures with which our various trips have been diversified, and to register the plants which have rewarded our labours. While we thus add to the knowledge of the Flora of our neighbourhood, we at the same time perpetuate the delightful associations connected with the scenes in which we met.

"All my botanical excursions," says Rousseau, "the several impressions which local objects gave, the ideas which in consequence sprung up, the little incidents which blended into the scene,—all these have produced a delightful impression which the sight of my herbarium rekindles. * * * * It is this association which makes botany so charming; it recalls back to the imagination all those ideas which afford the purest pleasure. Meadows, water, woods, and the inward contentment which dwells among such objects, are incessantly brought forward to the memory."

To these excursions may be applied the following remarks of Dr. Johnston of Berwick:—"They afford the stated means of indulging a principle bound up with our frame and constitution; for He who made nature all beauty to the eye, implanted at the same time in his rational creatures an instinctive perception of that beauty, and with it joined indissolubly a balm and virtue that operate through life. You have the proof of this in the gaiety of the infant swayed only by external influences; in the child's love of the daisy and the enamelled fields; in the girl's haunt by the primrose bank or rushy brook; in the schoolboy's truant steps by briery brake or flowery shaw, by trouting streams or nutting wood; in the trysting tree and green lanes of love's age; in the restless activity that sends us adrift in search of the picturesque; in the 'London pride' of the citizen; in the garden of retired leisure; in the prize-flower that lends its pride and interest to old age. Yes, there is a pre-ordained and beneficial influence of external nature over the constitution and mind of man which these excursions foster and encourage, and therein lies, in no small degree, their usefulness. The landscape before and around us becomes our teacher, and from the lesson there is no escape. Every cultivated mind must be improved by feeling the impulse of that beauty which has wooed it to peace, of that gratification and pleasure that entered in through every sense, and through the air we breathed and walked in. We are all the better of these excursions; they soothe or soften or exhilarate the man, and raise him in his own estimation by keeping awake his best feelings, and laying asleep for a season those that are of earth, earthy."

Glasgow possesses great facilities for the practical prosecution of botany. Besides having a rich and extensive botanic garden, it presents, by its railways and steam boats, a means of visiting easily during a course of lectures, districts characterised by every diversity of floral production, whether inland or maritime, lowland or alpine.

During the summer of 1843 I availed myself much of these advantages, and I now proceed shortly to notice the results of our excursions.

Our first excursion took place on the 13th of May, on which occasion we visited Bowling and the trap rocks in the neighbourhood of Old Kilpatrick. The rocks here are interesting to the mineralogist in consequence of yielding several good minerals, such as Prehnite, Stilbite and Thomsonite. We picked many of the early summer flowers, but none of great rarity. Among the plants gathered may be noticed Symphytum officinale, Melica uniflora, and Saxifraga hypnoides. Near the inn at Bowling Turritis glabra and Geranium columbinum have been found, but they were not in flower at the time of our visit.

On the 27th of May our party, amounting to twenty-four, proceeded by Kirkintilloch to Campsie, and examined the woods and hills in that quarter. In Campsie Glen, one of the most beautiful spots in the vicinity of Glasgow, we saw Stellaria nemorum, Geranium lucidum, Lathræa squamaria, Prunus Padus, Cardamine amara, Chrysosplenium alternifolium, and Equisetum Drummondii. On the hills above the glen, Viola lutea abounds; and here also Mr. Gourlie picked Allosorus crispus.* On descending into Finglen we found abundance of Paris quadrifolia,† Equisetum Drummondii, of which a few specimens were in fruit, Rubus saxatilis, Hymenophyllum Wilsoni, and Polygonum Bistorta. Returning by Mugdock Castle, we gathered Epimedium alpinum on an old wall; this plant has also been picked in woods at Garscube.

June 3d.—Proceeded by railway to Beith, and thence went to Kilbirnie Glen, and Glengarnock Castle, under the guidance of Mr. Levack, an enthusiastic botanist. The vegetation in this quarter was much less advanced than is usual at this season of the year, and the weather was particularly unfavourable. We saw Peucedanum Ostruthium, and Epilobium angustifolium in leaf, and gathered Trollius europæus, Geum intermedium, Habenaria chlorantha, and a considerable number of common plants. On the wooded banks of the river, near Glengarnock Castle, there is profusion of ferns; Polypodium vulgare, Phegopteris and Dryopteris, Athyrium Filix-fœmina, Lastræa Filix-mas, Oreopteris and multiflora, Asplenium Trichomanes

* This plant has also been found at Balvie, near Glasgow, and at Neilston Pad.

† This plant has also been found by Mr. Keddie at Waukmill Dam, near Barrhead.

and Adiantum-nigrum, Polystichum aculeatum, Blechnum boreale, Pteris aquilina, Scolopendrium vulgare, Cistopteris fragilis, were all picked within the space of a few yards. The party also examined the woods in the neighbourhood of Ladyland, where they were kindly entertained by Mr. Patrick.

June 10th.—On this day our route lay to the east of Glasgow. At Tollcross we found Ornithopus perpusillus, Teesdalia nudicaulis, and Erodium cicutarium. Proceeding to Hamilton, we visited the woods at Barncluith, and were rewarded with specimens of Doronicum Pardalianches, Ornithogalum umbellatum, Neottia Nidus avis, which was also found afterwards at Cadzow, Arum maculatum, Polemonium cæruleum, Anchusa sempervirens, Aquilegia vulgaris, and Veronica montana. Several of these plants appear to have escaped from the gardens in the vicinity, but they have now become naturalized. We looked in vain for Tulipa sylvestris, which is said to grow in this quarter. A little above Hamilton Typha latifolia used to be found, but it has now disappeared in consequence of drainage and other agricultural improvements.

On crossing the river Avon, and going towards Cadzow, we saw specimens of Geum intermedium, Sanicula europæa, Carex remota, sylvatica, pendula, and acuta, Rubus saxatilis, and Scolopendrium vulgare. In the old oak forest of Cadzow, Ophioglossum vulgatum was picked; and at the ruins of Cadzow Castle, Euonymus europæus, Viburnum Opulus, Ribes alpinum, Hieracium sylvaticum, and Gymnadenia albida.

June 17th.—The party this day went to Bothwell, and were enabled, under the guidance of Mr. Turnbull, (a well known and most successful cultivator,) to botanize in the grounds near the castle. Here Neottia Nidus-avis was again found, also Doronicum Pardalianches, Meconopsis cambrica, an escape from the garden, Epipactis latifolia, Allium vineale, Berberis vulgaris, Parietaria officinalis, Cheiranthus Cheiri, Sambucus Ebulus, Viburnum Opulus, Reseda Luteola, Polygonum Bistorta and Geranium sylvaticum. Near Blantyre priory Galium boreale, Viola odorata, Geranium phæum, Carex remota, Rumex alpinus, and Bromus arvensis were seen; and on the roadside between Blantyre priory and Cambuslang, Polemonium cæruleum was observed. Thalictrum flavum occurs on the banks of the Clyde near Carmyle, Galium Mollugo on the roadside between Cathcart and Rutherglen, and Impatiens Noli-me-tangere in Castlemilk glen.

June 23d.—On the afternoon of this day the party proceeded by railway and steam boat to Rothsay, and walked along the shore towards the south coast of Bute. Here we met with specimens of Saxifraga aizoides, Potamogeton oblongus, Cotyledon Umbilicus Habenaria bifolia and Osmunda regalis. On the morning of the 24th we left Rothsay, and proceeded by Etterick Bay along the shore to Scalpsie Bay. In the course of the walk the chief plants of interest which we collected were, Hesperis matronalis, Steenhammera maritima, Hippuris vulgaris, Potamogeton oblongus, Schoenus nigricans. Cotyledon Umbilicus, Sedum anglicum and acre, Hypericum elodes, Sinapis monensis, Glaucium luteum, Eryngium maritimum, and Carex arenaria. A little to the north of Scalpsie Bay Convolvulus Soldanella grows.

July 1st.—Proceeded by steamboat to Dumbarton, and landed at the trap rocks on which the Castle stands. Here we found Malva sylvestris and moschata, Conium maculatum, Smyrnium olusatrum, Vicia sativa, Carex muricata, Carduus marianus, Poa maritima and Sedum Telephium; several of these plants are by no means common in the neighbourhood of Glasgow. Leaving Dumbarton, we walked by the banks of the Leven to Tillichewan Castle, whither we had been kindly invited by Mr. William Campbell, to whose hospitality we were much indebted. Among the plants noticed we may record Ranunculus aquatilis and hederaceus, Solanum Dulcamara, Habenaria bifolia and chlorantha. In the woods near the Castle, Carex remota and lævigata, Viburnum Opulus, Lastræa Oreopteris and Polypodium Phegopteris occur.

July 7th.—The Railway Train took the party to Stirling road, whence they walked to Carluke and Lanark, and on the way picked Rumex aquaticus and Jasione montana. On the morning of the 8th we visited Cartland Crags, and after examining both sides of the glen proceeded to the Falls of Clyde at Stonebyres, and then returned to Lanark to breakfast. In this excursion many plants of interest were seen, such as, Arabis hirsuta, Melica nutans and uniflora, Spiræa salicifolia, Digitalis purpurea var. alba, Carduus heterophyllus, Ononis arvensis, Epilobium angustifolium, Origanum vulgare, Saxifraga hypnoides, Galium boreale, Helianthemum vulgare, Vicia sylvatica, and in some parts of the woods, apparently naturalised, Lilium Martagon and Gnaphalium margaritaceum. At the Stonebyres Falls, Carex pendula, Festuca elatior, Solidago virgaurea, Apargia hispida and autumnalis, Campanula rotundifolia and Hypericum hirsutum. After breakfast, the party visited the banks of the Clyde at New Lanark, and found Carex intermedia, paniculata, remota and fulva. At Cora Linn, Saxifraga oppositifolia and Asplenium viride occur—the latter plant having been first picked in this locality by Mr. Gourlie. Both these plants occur here at a much lower elevation than usual, and they are not, so far as I know, met with on Tinto, or the other hills in the neighbourhood. Their appearance, therefore, in this locality, is by no means easily accounted for. Associated with them we found Lycopodium selaginoides, Aquilegia vulgaris and Rubus saxatilis. In the woods around, Equisetum Drummondii grows in profusion. Near Bonnington Falls, we met with Vicia Orobus, Spiræa salicifolia, Campanula latifolia and Carex acuta. Mr. James Murray, who visited Tinto, picked Rubus Chamæmorus and Vaccinium Vitis-Idæa, on that mountain. Carum Carui was also found near Cormieston, and Thlaspi arvense near Skirling.

July 11th.—On the afternoon of this day we took a botanical walk along the banks of the Clyde, as far as Scotstown, and examined also the banks of the Kelvin, where it joins the Clyde. Among the plants which we observed, may be mentioned, Triticum repens, Convolvulus sepium, Rumex aquaticus, which was very abundant in many places, Festuca elatior, pratensis and loliacea near the mouth of the Kelvin, Sinapis alba, Galeopsis versicolor, Conium maculatum, Lythrum Salicaria, Epipactis latifolia, Sedum Telephium, Carduus acanthoides, Callitriche platycarpa and verna, Geranium pratense, Senecio aquaticus, and Mimulus luteus. The last mentioned plant, which is originally from Chili, has become naturalised in many places in this neighbourhood. It occurs also in other parts of the country, as near Dunvegan, in Skye.

July 13th.—Our party went by railway to Ardrossan, and thence to Arran, where we spent two days examining the Flora of the island. Near Brodick many interesting plants are found, which have been noticed in an account of a previous trip.* In addition to the plants enumerated there we may notice Cephalanthera ensifolia as having been picked in the woods between Brodick and Lamlash by Mr. Gourlie. On this occasion our route lay toward the northern part of the island.—From Brodick we walked to Corrie, and on the way picked Œnanthe Lachenalii, Erythræa linarifolia, Juncus maritimus, and Scutellaria galericulata. On the morning of the 14th July we left Corrie, and proceeded along the shore to the Cock of Arran, and thence to Loch Ranza to breakfast. The geological formations presented objects of no ordinary interest. Our attention was particularly called to the junction between slate and granite, the anticlinal axis, and the fallen rocks, all of which are so well described by Mr. Andrew Ramsay in his excellent account of Arran. The slate and carboniferous series of rocks near the shore, we found to be, generally speaking, unproductive of rare plants, while the new and old red sandstone and the trap furnished an excellent field for our botanical researches. Among the species remarked were Juncus maritimus, Scirpus pauciflorus, Blysmus rufus, Aster Tripolium, Osmunda regalis, Cotyledon Umbilicus, Solanum Dulcamara, Scutellaria galericulata, Habenaria chlorantha and bifolia, Sinapis monensis, Filago germanica and minima, Ammophila arenaria, Triticum junceum, Carex arenaria, Lythrum salicaria, Hypericum androsæmum, Galeopsis versicolor, and Lamium intermedium. After breakfast we continued our route along the shore to Dugarry, where we took up our quarters in some small cottages, the only accommodation which we could procure in this quarter of the island. In this part of our trip we gathered Salicornia herbacea, and Chenopodium maritimum, Steenhammera maritima, Crambe maritima, Stachys arvensis, and Thlaspi arvense. On the 15th of July we left Dugarry, and proceeded to Black Water

* See Phytologist for 1842.

Foot, and on our way observed Carex paniculata, Lithospermum officinale, Agrimonia Eupatorium, Hypericum dubium, and Androsæmum Littorella lacustris, Blysmus rufus, Convolvulus Soldanella, Sinapis monensis, Carex arenaria, Eleocharis fluitans, and Scirpus maritimus. From Black Water Foot our road lay through an unproductive district across the island to Brodick, whence we proceeded to Ardrossan.

July 22d.—Visited Ayr, and examined the shores in the neighbourhood. The chief species which we found were Atriplex laciniata and rosea, Salsola kali, Eryngium maritimum, Sinapis monensis, Iberis amara, Hyosciamus niger, Senebiera Coronopus, Malva moschata, Beta maritima, Crambe maritima, and Cakile maritima. Near Grinan Castle Trifolium scabrum and Tanacetum vulgare were picked, as well as Acinos vulgaris and Trifolium arvense.

July 28th.—Proceeded by steamboat up Loch Long to Arrochar, where we took up our quarters for two days. On the afternoon of this day we visited the hills at the upper part of the Loch, but the state of the weather prevented us from making a thorough examination of them. We saw only a few alpine plants, such as Saxifraga aizoides, oppositifolia, stellaris and hypnoides, Epilobium alpinum, Thalictrum alpinum, Salix herbacea, Gnaphalium supinum, Juncus triglumis and trifidus, Hieracium alpinum, Oxyria reniformis, Asplenium viride, Rhodiola rosea, Vaccinium uliginosum, Aira alpina, and variety vivipara, Festuca vivipara, Lycopodium Selago, selaginoides and alpinum. On the 29th the weather was still very unpropitious, and the thick mist and rain interfered considerably with our botanical rambles. Nevertheless we went by the banks of Loch Lomond to Upper Inveruglas, and thence ascended Benima and the Cobbler. On the banks of the Loch we found Hymenophyllum tunbridgense, Osmunda regalis, and Hypericum Androsæmum. On the ascent of Benima, Carex irrigua was first picked by Mr. Adamson, and on ascending the hills, various interesting alpine plants were procured, such as Carex saxatilis, and Juncus castaneus, discovered by Mr. Gourlie, Carex pauciflora and rigida, Silene acaulis, Gnaphalium supinum, Juncus trifidus and triglumis, Sibbaldia procumbens, Veronica humifusa, Epilobium alpinum, Rhodiola rosea, Luzula spicata, Saussurea alpina, Cerastium alpinum, Festuca vivipara, Vaccinium uliginosum, Salix herbacea, Saxifraga oppositifolia, aizoides, stellaris and hypnoides, Allosorus crispus, Asplenium viride, and Cetraria islandica.

Names of Gentlemen who joined the Excursions in 1843.—Robert Rainy, Nathaniel Stevenson, jun., J. Stevenson, jun., J. C. Stevenson, Edward Alexander, jun., T. Alexander, John Alexander, Robert Balloch, Ebenezer Watson, David Miller, James Bain, David Nelson, Thomas Waugh, James M'Gregor, Donald G. M'Lellan, Robert White, David D. Service, William Ramsay, William Keddie, William M'Leod, John R. Peebles, Walter Bain, James Couper, Andrew Craig, William Henderson, jun., William Kidston, John Struthers, William Naismith, John Burns, G. Macculloch, Andrew Paterson, John Thomson, sen., John Thomson, jun., James C. Murray, William Gourlie, Frederick Adamson, G. J. Lyon.

BOOKS

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CONTINUED FROM PAGE 60.

MISCELLANEOUS BOOKS.

Carpenter's Principles of Human Physiology.
Pritchard's History of Man.
Pereira's Treatise on Food and Diet.
Dieffenbach's Travels in New Zealand, 2 vols.
Beaumont on Digestion.
M'William's Medical History of the Expedition to the Niger in 1841-42.
Owen's Lectures on Comparative Anatomy.
Liebig's Agricultural Chemistry, third edition.
Hooker's Notes on the Botany of the Antarctic Voyage.
Liebig's Familiar Letters on Chemistry.

PERIODICALS.

Memoirs and Proceedings of the Chemical Society of London, vol. I. (*Presented by that Society.*)

Third Annual Report of the Registrar General,				for 1841.	*Presented.*
Fourth	do.	do.	do.	for 1842.	
Fifth	do.	do.	do.	for 1843.	
London Weekly Mortality Bills,				for 1843.	
Do.	do.	do.		for 1844.	

Hooker's Journal of Botany, *Monthly.*
Paxton's Magazine of Botany, *Monthly.*
Journal of Agriculture of the Highland Society, *Quarterly.*
The Phytologist, *Monthly.*
Journal of the Statistical Society of London, *Quarterly.*
Annual Reports and Transactions of the Edinburgh Botanical Society.
Proceedings of the Berwickshire Naturalists' Club, for 1843. *Presented by Dr. Balfour.*

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Strang, William, 22 Argyle-Street.
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Sword, James, jun., Eastfield.

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