Lendenfeld, studies on Sponges: (1) the vestibule of *Dendrilla cavernosa*, sp.n.; (2) on *Raphyrus luxonii*, a new gigantic species from Port Jackson; (3) *Halme tingens*; (4) two cases of mimicry in Sponges (plates 39-43).—On recent changes in the forest flora of the interior of New South Wales; notes how the Pine Scrub (Callitris) rapidly supersedes the angiospermatous trees. The larva of a beetle (*Diadoscus erythrurus*) in part keeps the pine in check; drought seems favourable to the development of the beetle, or at least, by affecting the vegetation of the pine, enable its ravages to be more felt.—On the Australian fresh-water Rhizopoda.—On an Alga forming a pseudomorph of a siliceous Sponge.—On the dorsal papillæ of Onchidium.—Fourth addendum to the Australian Hydromedusæ.—E. P. Ramsay and J. Douglas-Ogilby, descriptions of many new or rare fishes.—George Masters, catalogue of the described Coleoptera of Australia, part 2.—N. de Miklouho-Maclay and Wm. Macleay, the Plagiostomata of the Pacific, part 3 (plates 45, 46).—A. Sidney Olliff: Trogositidæ of Australia.—On a new species of Chrysophanus.—On Australian Ptinidæ.—W. A. Haswell, on some Australian Polychæta, part 1 (plates 50-55).—E. Meyrick, Australian Micro-Lepidoptera.—J. Brazier, a new Ochidium.—New land and fresh-water Mollusca from New Guinea.

Second series, vol. i. part 1, with 6 plates (May 25, 1886).—E. P. Ramsay and J. Douglas-Ogilby, descriptions of new Australian fishes; new species of fish from New Guinea; a new Coris from the New Hebrides.—E. P. Ramsay, on a new genus and species of fresh-water tortoise from the Fly River, New Guinea (plates 3-6).—George Masters, catalogue of Australian Coleoptera, part 3.—F. Ratte, *Crioceras australe*, Moore (?), a Lower Cretaceous fossil from Queensland (plates 1, 2).—Wm. Macleay, the insects of the Fly River, New Guinea.—C. W. de Vis, on some Geckos in the Queensland Museum.—A. S. Olliff, on a new Aphanipterous insect from New South Wales.—Wm. A. Haswell, on the myology of *Petaurista taguanoides*.—Capt. F. W. Hutton, the Mollusca of the Pareora and Oamaru systems of New Zealand.

Proceedings of the Royal Society of Queensland, vol. ii. parts 1 and 2, June 1886, contain, among others:—W. E. Armit, notes on the philology of the islands adjacent to the south-eastern extremity of New Guinea (pp. 2-12), and on the Papuans (pp. 78-116).—C. W. De Vis, on the bones and teeth of a large extinct lizard (pp. 25-31, plates 1-3).—On an extinct Ornithorhynchus (pp. 35-40, plate 4).—On some new species of Salarias, and on a new species and genus of lizard (pp. 56-61).—On a fossil Saurian (pp. 181-192, plates 10-15).—Henry Tryon, on Queensland harvesting-ants.—W. A. Tully, short account of the measurement of the base-line in connection with the trigonometrical survey of Queensland.—Baron von Müller, on a new tiliaceous tree (*Elæocarpus Bancroftii*) from North Eastern Australia.

Proceedings of the Royal Society of Tasmania for 1885 (Tasmania, 1886).—From the records of the *Proceedings* it is interesting to learn that, though the Society has lost the exclusive control over the Museum and Gardens, which now are managed by trustees, some of whom are elected by the Society, yet the work of the Society continues to develop, and its library to increase. This volume is accompanied by a sketch-map, coloured, giving the general geological features of Tasmania, by C. P. Sprent and R. M. Johnston; and a geological chart, by Mr. Johnston, showing the proposed provisional classification of the stratified rocks of Tasmania and their equivalents elsewhere.—Among the more important papers we note the following:—R. M. Johnston, various memoirs on the geology and palæontology of Tasmania.—R. A. Bastow, on the mosses and Jungermania of Tasmania.—W. F. Pettard, new Tasmanian marine shells.—Baron F. von Müller, notes on J. J. H. de Labillardière (with a portrait).—Capt. Shortt, earthquake-phenomena in Tasmania.—T. Stevens, on boring for coal in Tasmania.

ON THE OCCURRENCE OF CELLULOSE IN TUBERCULOSIS

CELLULOSE, the principal constituent of the vegetable cell-wall, has been found to occur also in some animals; the mantle of *Phallusia mamillaris* and of Cynthia, and the external coat of Salpa consist mainly of tunicin, or animal cellulose. Now a further very valuable contribution to our knowledge of the occurrence of this body has been made in Vienna by Herr Ernst Freund, working at Prof. E. Ludwig's laboratory. Freund has succeeded in preparing from some of the organs and blood of tuberculous persons a substance exactly resembling cellulose, and showing all the reactions which have hitherto been described as peculiar to the latter. The reactions employed were the following:—(1) Conversion of cellulose when dissolved in concentrated sulphuric acid into dextrose on boiling with dilute sulphuric acid; (2) resistance if treated with Schultze's reagent, a mixture of nitric acid and chlorate of potassium; (3) yielding of a collodion-like mass by the action of nitric acid and ether; (4) assuming a blue colour by the action of iodine in presence of concentrated sulphuric acid or chloride of zinc solution; (5) assuming a violet colour by the action of a naphthol when dissolved in concentrated sulphuric acid (Molisch's reaction); (6) insolubility in common (indifferent) solvents (dilute alkalies); (7) solubility in a solution of cupric hydroxide in ammonia. The substance obtained from miliary tubercles and from the blood of tuberculous persons was subjected to ultimate analysis in three cases, and yielded between 45·12 and 44·70 per cent. C, and between 6·41 and 6·19 per cent. H; while 44·74 per cent. C and 6·17 per cent. H corresponds to $C_6H_{10}O_5$. A quantitative determination of the cellulose of the tubercles has not been made. The researches were carried out on material from twenty-five tuberculous and thirty non-tuberculous cases. The tuberculous material (lungs, spleen, peritoneum with miliary tubercles, blood) embraced cases of conglomerated as well as of infiltrated tuberculosis in the different stages of the disease. The non-tuberculous material examined was taken partly from healthy organs, partly from organs affected by various diseases—as, *e.g.*, from pneumonia, emphysema, pulmonary gangrene—and failed to show any of the reactions described above. Carcinomatous, sarcomatous, lupoid, syphilitic, and other non-tuberculous granulations were also examined with negative results. From his researches Herr Freund makes the suggestion that in tuberculous growths and in the blood of tuberculous persons cellulose forms an intrinsic constituent. We need not refer to the importance and suggestiveness of Freund's discovery for pathological science, making further researches on this subject very desirable.

DISINFECTION BY HEAT

THE Annual Report for 1884 of the Medical Officer of the Local Government Board contained a memoir, by Dr. H. F. Parsons, on the subject of disinfection by heat. Of this memoir the leading points are here given.

In considering the applicability of heat as a means of disinfection, several distinct questions present themselves for solution. It has first of all to be determined what degree of heat and duration of exposure are necessary under different conditions, as of moisture and dryness, in order to destroy with certainty the activity of the contagia of infectious diseases.

We have next to ascertain how the required degree of heat may be made to penetrate through bulky and badly conducting articles, *e.g.* of clothing and bedding, for the disinfection of which the application of heat is especially employed.

We have also to learn whether such articles can be submitted to the required degree of heat without injury, for if not, disinfection presents little advantage over destruction.

After giving a *résumé* of the results of previous experiments to ascertain the degree of heat necessary to destroy the contagia of infectious diseases, from those of Dr. Henry published in the *Philosophical Magazine* for 1831, to those of Koch and his coadjutors (*Mittheilungen aus dem kaiserlichen Gesundheitsamte*, Berlin, 1881), the author states the results of a series of experiments made by him in conjunction with Dr. Klein, who prepared the infective materials, and, after these had been exposed to disinfecting processes, tested the results by inoculation on animals; control inoculations with unheated portions of the same materials being also in all cases made.

The following were the infective materials employed:—

(1) Blood of guinea-pig dead of anthrax, containing bacillus anthracis without spores.

(2) Pure cultivation of bacillus anthracis in rabbit broth, without spores.

(3) Cultivation of bacillus anthracis in gelatine, with spores.

(4) Cultivation of bacillus of swine fever (infectious pneumo-enteritis of the pig) in pork broth.

(5) Tuberculous pus, from an abscess in a guinea-pig which had been inoculated with tubercle.

Infectious pneumo-enteritis of the pig (swine fever) has been shown by Dr. Klein to be caused by the introduction into the body of the affected animal of a specific bacillus. This disease among pigs is highly infectious, the contagium being transmissible from pig to pig through the air, and persisting in infected buildings in a similar manner to the observed behaviour of small-pox and scarlet fever among human beings; and, though not transmissible to mankind, it can be inoculated upon rodents, although in the latter animals it is not contracted by infection received through the air.

The experiments on the disinfecting power of dry heat were mostly made in a copper hot-air bath, or in one improvised of flower-pots, and furnished with a Bunsen's regulator; those with steam were made in a felt-covered tin cylinder, through which passed a stream of steam from a kettle beneath.

The mode of procedure in exposing the materials to heat was as follows:—Strips of clean flannel were steeped in the respective infective fluids, dried in the air, wrapped separately and loosely in a single layer of thin blotting-paper, and suspended in the centre of the apparatus in company with a thermometer, so placed that its bulb was close to the packets of infected material.

The following were the results of the experiments with dry heat:—

Anthrax bacilli without spores were sterilised by exposure for five minutes only to a dry heat varying between 212° and 218° F.

Spore-bearing cultivations of the bacillus anthracis, on the other hand, did not lose their vitality by a two hours' exposure to 220° F., but were sterilised by exposure for four hours to 220° F., or one hour to 245° F.

A rabbit inoculated with swine fever virus which had been exposed to dry heat varying between 212° and 218° F. for an hour remained well; but one inoculated with virus exposed to a similar heat for only five minutes, died of swine fever after nineteen days, the usual time of death after inoculation being between five and eight days.

Guinea-pigs inoculated with tuberculous pus exposed for five minutes to 220° F. remained well.

The foregoing results, as far as regards anthrax, are far more favourable to the efficacy of dry heat as a disinfecting agent than those of Koch. It appears that the spores of the bacillus anthracis lost their vitality, or at any rate their pathogenic quality, after exposure for four hours to a temperature a little over the boiling-point of water, or for one hour to a temperature of 245° F. Non-spore-bearing bacilli of anthrax and of swine fever were rendered inert by exposure for an hour to a temperature of 212°–218°, and even five minutes' exposure to this temperature sufficed to destroy the vitality of the former, and impair that of the latter.

As none of the infectious diseases for the extirpation of which measures of disinfection are in practice commonly required are known to depend upon the presence of bacilli in a spore-bearing condition, it is concluded that, as far as our present knowledge goes, their contagia are not likely to retain their activity after being heated for an hour to 220° F.

In the experiments with steam the results were conclusive as to the destructive power of steam at 212° F. upon all the contagia submitted to its action. In one instance only was there room for suspicion that the disinfection had not been complete: this was in the case of the highly-resisting anthrax spores, exposed to steam for five minutes only: the animal had six days afterwards a swelling at the seat of inoculation, but remained well. On the other hand the animals inoculated with unheated portions of the same materials all died.

These results are in accordance with those of Koch, Gaffky, and Löffler, and it may be considered established that the complete penetration of an object by steam heat for more than five minutes is sufficient for its thorough disinfection.

In view of the above satisfactory results it was not deemed necessary to make any experiments as to the disinfecting power of steam at higher temperatures or under pressure, its efficacy being taken for granted.

Dr. Klein found that boiling in water for only one minute was sufficient to render inert the spores of the bacillus anthracis, although it is known that some of the spore-bearing non-pathogenic bacilli are only destroyed by prolonged boiling, or by a moist temperature above the boiling-point.

Some observations were made on the destruction of lice by heat. It was found that the eggs of lice could be conveniently hatched by tying up tightly in muslin a small piece of the garment on which they were deposited, and carrying it about for a week or two in a warm pocket. Tested in this way no development was found to take place in eggs of lice which had been exposed for one hour to 300° F. dry heat, for one hour to 230° F. dry heat, or for ten minutes to steam at 212° F., or which had been boiled for five minutes in water. The maximum heat which lice or their eggs will bear with impunity was not ascertained.

In order to secure the thorough and certain disinfection by heat of porous articles likely to retain infection, such as clothing and bedding, it is necessary that the heat should be made to permeate the articles in every part to such a degree and for such a length of time as to destroy all infectious matter which they may contain.

It has been remarked that such articles as bedding and blankets are the highest outcomes of the ingenuity of man to check the passage of heat from one side of the object to the other. It is no wonder, therefore, that they should be found difficult of penetration by heat. Even thin layers, however, of badly conducting substances interpose a considerable barrier to the passage of dry heat. The following experiment was made to ascertain how far the inclosing of infective objects in blotting-paper or test-tubes plugged with cotton wool (as in Dr. Koch's experiments) hindered the full access of heat to them.

Two similar registering thermometers were taken: the bulb of one was tied up in a single layer of thin white blotting-paper, that of the other was placed in a test-tube ⅜ inch wide in such a manner as not to touch the sides, and a plug of white cotton wool 1 inch deep was pushed into the tube around the stem of the thermometer, but not as far as the bulb. Both the paper and cotton wool were previously dried. The two thermometers, together with another with bare bulb, were then hung up in a hot-air bath. Heat being applied, the thermometers were read half-hourly as follows:—

Time from lighting	Readings of thermometer with bulb Bare ° F.	 In paper ° F.	 In tube ° F.
½ hour ...	162 ...	147 ...	151
1 hour ...	212 ...	193 ...	196
1½ hour ...	234 ...	213 ...	219
2 hours ...	242 ...	236 ...	238
2½ hours ...	244 ...	244 ...	244

The following experiment was made with a thermometer having the bulb covered with a single layer of blanket and placed in the hot-air bath already heated:—

Time from placing in hot-air bath	Thermometer with bulb bare ° F.	Thermometer with bulb in blanket ° F.
½ hour ...	246 ...	231
1 hour ...	260 ...	250
1½ hour ...	266 ...	254
2 hours ...	268 ...	263
2½ hours ...	268 ...	264

Experiments made with larger articles and apparatus showed how difficult it was to secure the penetration of a dry heat sufficient for disinfection into the interior of such an object as a pillow. It was only effected by employing a high degree of heat, or by continuing the exposure during many hours, length of exposure compensating for a lower degree of heat. On the other hand heat in the form of steam penetrates much more rapidly than dry heat. Thus a thermometer in a roll of dry flannel placed in a hot-air bath at 212° F., at the end of an hour registered only 130° F. In the same roll, placed in the steam cylinder for ten minutes, the thermometer marked 212° F. Experiments on the large scale were equally conclusive. The causes of the superior penetrative power of heat in the form of steam over hot air appear to be:—

(1) The large amount of latent heat in steam, set free on its condensation. In hot dry air, on the other hand, the evaporation of hygroscopic moisture takes up heat and delays the attainment of the required temperature.

(2) Steam, on condensation into water, occupies but a very small fraction of its former volume and thus makes room for more. Hot air in cooling diminishes in volume in much less proportion.

(3) The heat evolved in the moistening of a dry porous substance. In the centre of a highly-dried roll of flannel placed in the cylinder in a current of steam at 212° F., a thermometer, after five minutes' exposure, registered 239° F.

(4) The higher specific heat of steam than of air.

(5) The greater diffusive power of steam than of air.

(6) The effects of pressure. By applying steam under pressure, relaxed and reapplied from time to time, so as to displace the cold air remaining in the interstices of the material, we have a means of considerably increasing the penetrative power of the steam.

In view of the superior efficacy of steam, both in the destruction of infective matters and in the penetration of badly-conducting materials, some experiments were made with moist air in the hope that it might be found possible to obtain the advantages of the use of steam without its drawbacks.

In these experiments either an evaporating vessel containing water was placed at the bottom of the hot-air chamber, or steam evolved in a separate boiler was led into the chamber by a pipe.

An attempt was made to measure the degree of humidity of the air by suspending in the chamber two maximum-registering thermometers arranged side by side, one of them having its bulb covered with gauze kept moist by dipping in a phial of water, as in the wet-and-dry-bulb arrangement employed by meteorologists. It appears, however, that there are no tables or formulæ in existence by which the degree of humidity of the air corresponding to a given difference between the wet and dry bulb thermometers at these high temperatures can be ascertained. The conditions in a heated chamber are so different from those met with in meteorological practice, that it is doubtful whether the relative humidity of the air could be obtained in this way with any great degree of accuracy; but a comparison of the readings of the wet and dry bulb thermometers was found in practice to be useful as a rough indication of the dryness or dampness of the air, although the readings could not be reduced to a common measure.

The experiments seem to show conclusively that moistening the air of the heated chamber diminishes the time necessary for the penetration of heat into a badly-conducting object. As examples the following observations may be quoted. They were made in an iron chamber heated by a furnace underneath, and furnished with a pipe by which steam could be admitted.

		No steam admitted	A small jet of steam admitted	Large jet of steam admitted
Maximum readings of thermometers hung up in chamber	Dry bulb	299° F.	299° F.	249° F.
	Wet bulb	146°	165°	190°
Temperature attained in centre of similar pillows exposed for one hour in heated chamber		136°	188°	209°

The moistening of the air of the heated chamber by either method was further found to have the advantage of rendering more equable the distribution of temperature in different parts of the chamber, thus tending to prevent scorching of the articles placed therein.

On the other hand it was not found that the presence of moisture in proportions such as these, or even greater, increased the disinfecting effect at the temperature employed; spores of the bacillus anthracis retained their vitality equally well in heated air whether it were moist or dry; thus they caused the death of a guinea-pig after exposure for an hour to a temperature of {dry bulb 220° F. / wet bulb 190° F.} whereas five minutes' exposure to a current of steam at 212° F. was sufficient to render them inert.

To avoid risk of injury to articles subjected to disinfection by heat is an important practical question, not only on account of the value of the articles themselves, but also because, if the exposing of such articles to heat be attended with risk of injury, there is danger lest, to avoid this risk, they may not be sufficiently heated to insure disinfection. The following are the principal modes in which injury may occur; they are somewhat different in the case of steam from that of dry heat:—

1. Scorching or partial decomposition of organic substances by heat. In its incipient stages this manifests itself by changes of colour, changes of texture, and weakening of strength.
2. Overdrying, rendering materials brittle (by dry heat).
3. Fixing of stains, so that they will not wash out.
4. Melting of fusible substances, as wax and varnish, and ignition of matches accidentally left in pockets.
5. Alterations in colour, gloss, &c., of dyed and finished goods.
6. Shrinkage and felting together of woollen materials.
7. Wetting (by steam).

Scorching begins to occur at different temperatures with different materials, white wool being soonest affected. It is especially apt to occur where the heat is in the radiant form. To avoid risk of scorching the heat should not be allowed much to exceed 250° F., and even this temperature is too high for white woollen articles.

By a heat of 212° and upwards, whether dry or moist, many kinds of stains are fixed in fabrics so that they will not wash out. This is a serious obstacle in the way of the employment of heat for the disinfection previous to washing of linen, &c., soiled by the discharges of the sick.

Steam disinfection is inapplicable in the case of leather, or of articles that will not bear wetting. It causes a certain amount of shrinkage in textile materials, about as much as an ordinary washing. The wetting effect of the steam may be diminished by surrounding the chamber with a jacket containing steam at a higher pressure, so as to superheat the steam in the chamber.

For articles that will stand it, washing in boiling water (with due precautions against re-infection) may be relied on as an efficient means of disinfection. It is necessary, however, that before boiling the grosser dirt should be removed by a preliminary soaking in cold water. This should be done before the linen leaves the infected place.

The objects for which disinfection by dry heat or steam is especially applicable are such as will not bear boiling in water, *e.g.*, bedding, blankets, carpets, and cloth clothes generally.

Apparatus for disinfection by heat may be classified as follows:—

(a) *By hot air*—

1. Apparatus in which the heat is applied to the outside of the chamber, and the products of combustion do not enter the interior.
2. Apparatus in which the heated products of combustion enter the interior.
3. Apparatus heated by steam or hot water circulating in closed pipes.
4. Apparatus in which air previously heated is blown into the chamber.

(b) *By steam*—

5. By a current of free steam.
6. By steam confined in a chamber at pressures above that of the atmosphere.

The most important requisites of a good apparatus for disinfection by heat are (*a*) that the temperature in the interior shall be uniformly distributed; (*b*) that it shall be capable of being maintained constant for the time during which the operation extends; and (*c*) that there shall be some trustworthy indication of the actual temperature of the interior at any given moment. Unless these conditions be fulfilled, there is risk, on the one hand, that articles exposed to heat may be scorched, or on the other hand, that through anxiety to avoid such an accident the opposite error may be incurred, and that the articles may not be sufficiently heated to insure their disinfection.

In dry-heat chambers the requirement (*a*) is often very far from being fulfilled, the temperature in different parts of the chamber varying sometimes by as much as 100°. This is especially the case in apparatus heated by the direct application of heat to the floor or sides of the chamber. The distribution of temperature is more uniform in proportion as the source of heat is removed from the chamber, so that the latter is heated by currents of hot air rather than by radiation.

There is a marked difference between the distribution of temperature in a chamber heated primarily by radiant heat and in one heated by the admission of hot air or steam. Radiant heat is most intense close to its source, diminishing rapidly as we recede therefrom. Also it does not turn corners, and thus objects lying behind others are screened from it, except so far as it may be reflected upon them from other surfaces. The rays strike the walls of the chamber and objects therein, so that these are more highly heated than the air, which becomes heated only secondarily by contact with them.

On the other hand, if air already heated, or steam, be admitted into a chamber, the temperature tends to equalise itself in the different parts, and the walls and solid contents of the chamber do not become hotter than the air.

In chambers heated by gas, when once the required temperature has been attained, but little attention is necessary to maintain it uniform, and in the best-made apparatus this is automatically performed by a thermo-regulator. On the other hand, in apparatus heated by coal or coke the temperature continually tends to vary, and can only be maintained uniform by constant attention on the part of the stoker.

In very few hot-air chambers did the thermometer with which the apparatus was provided afford a trustworthy indication of the temperature of the interior; in some instances there was an error of as much as 100° F. This is due to the thermometer, for reasons of safety and accessibility, being placed in the coolest part of the chamber, and to the bulb being inclosed for protection in a metal tube which screens it from the full access of heat. The difficulty may be overcome by using, instead of a thermometer, a pyrometer actuated by a metal rod extending across the interior of the chamber.

In steam apparatus the three requirements above mentioned are all satisfactorily met, and for this reason, as well as on account of the greater rapidity and certainty of action of steam, both in penetrating badly conductive materials and in destroying contagia, steam chambers are, in Dr. Parsons's opinion, greatly preferable to those in which dry heat is employed.

It is important that the arrangements of the apparatus, the method of working, and the mode of conveyance to and fro, should be such as to obviate risk of articles which have been submitted to disinfection coming into contact with others which are infected.

The latter part of the Report is taken up with descriptions of the various forms of apparatus in use for disinfection by heat, and accounts of experiments made with a view to test their practical efficiency.

ON THE FRACTIONATION OF YTTRIA[1]

HAVING already explained the methods of chemical fractionation, it may be useful now to describe some of the results yielded by an extended perseverance in these operations.

I must, in the first place, explain that my work has been confined to a limited and very rare group of bodies—the earthy bases contained in such minerals as samarskite, gadolinite, &c. These have been repeatedly put through the fractionation mill by other chemists, but the results have been most unsatisfactory and contradictory, no sufficiently good test being known whereby the singleness of any earth got out by fractionation could be decided, except the somewhat untrustworthy one of the atomic weight. I say *untrustworthy*, because it is now known that fractionation, unless it is pushed far beyond the point to which some Continental chemists have even carried it, is quite as liable to give *mixtures* which refuse to split up under further treatment of the same kind, as it is to yield a chemically simple body. This I have fully gone into in my paper "On the Methods of Chemical Fractionation." The unsatisfactory nature of fractionation work may be seen from expressions used, in private letters to me, by some of the eminent chemists who have almost made this method their own. One writes—"It is very tiresome working with the rare earths, as we never can be sure when we have got a definite result. There will never be an end to their history. I am very tired of it, and am much inclined to give it up." Another writes—"Unfortunately I commenced my researches on the rare earths with too little material, and I have not had the courage, at my age, to recommence the work on more abundant material. The further I advance in my work the more I am convinced that no known method permits of the complete separation of these different earths one from the other." A third writes—"One loses so much material in the separations that it appears to me scarcely possible, with the material available, to arrive at a successful solution of the question." I could multiply similar quotations, all breathing the same almost despairing spirit.

It would certainly not have been prudent on my part to invite a time-honoured comparison, and "rush in" where so many eminent men "fear to tread," were it not that good fortune had placed in my hands a physical test for these obscure molecular groupings which is of the most exquisite sensitiveness. I refer to what I have for shortness called the Radiant-Matter test.

It is well known that a limited group of these rare earths, when phosphoresced *in vacuo*, yield discontinuous spectra. The method adopted to bring out the spectra is to treat the substance under examination with strong sulphuric acid, drive off excess of acid by heat, and finally to raise the temperature to dull redness. It is then put into a radiant-matter tube of the form shown in Fig. 1, and the induction spark is passed through it after the exhaustion has been pushed to the required degree. The phosphorescence occurs beneath the negative pole. As each gaseous molecule, carrying its charge of negative electricity with it, strikes the earthy sulphate, it has a tendency to part with its charge, provided it finds a body ready to take up the electricity; otherwise it retains its charge. Bodies like yttrium sulphate, &c., easily take the electric charge, and under the stimulus phosphoresce, emitting light whose waves tend to collect round definite centres of length. The phosphorescent light which the discharge evokes is best seen in a spectroscope of low dispersion, and with not too narrow a slit. In appearance the bands are more analogous to the absorption-bands seen in solutions of didymium than to the lines given by spark spectra. Examined with a high magnifying power, all appearance of sharpness generally disappears: the scale measurements must therefore be looked upon as approximate only; the centre of each band may be taken as accurately determined within the unavoidable errors of experiment, but it is impossible to define their edges with much precision. The bands are seen much sharper when the current first passes than after the current has been passing for some time and the earth has become hot. On cooling, the sharpness of the bands re-appears.

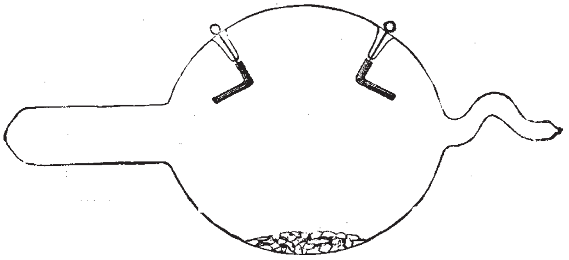

FIG. 1.

As a general rule, the purer the earth the sharper the band, and when impurities are removed to the utmost extent, the sharpness is such as to deserve the name of a line. This may be illustrated by mixing together yttria and lime. Lime phosphoresces with a continuous and yttria with a discontinuous spectrum. Mixed together, the phosphorescing energy of the lime does not spend itself over the whole spectrum, but concentrates itself in greatly reinforcing the yttria bands. A molecule of yttria vibrating with a definite wave-length gives a nearly sharp line, but the molecule of lime with which it is weighted has no special tendency to vibrate to one wave-length more than another. The yttria induces the right vibration in the adjacent molecule of lime; but this lime, once set in vibration, cannot confine itself to the exact wave-length required, and overflows a little on each side, and the result is a widening and blurring of the bands, becoming greater in amount as the extraneous earth increases in quantity.

To this rule one exception occurs. The body which I have named Sδ, or 609, is remarkable for the great sharpness of its phosphorescent line, and I have noticed scarcely any variation in its sharpness, however large the bulk of extraneous earth associated with it. This line, however, is sharper and brighter when the current is first turned on than it is after the earth has been phosphorescing for a minute or so.

In the Bakerian lecture on yttrium delivered before the Royal Society (*Phil. Trans.* Part 3, 1883), I described the phosphorescent spectrum given by this element, and in the address which I have had the honour of delivering before this Section I gave a drawing of the spectrum of yttrium, together with a sketch of the train of reasoning by which I had been led to the opinion that excessive and systematic fractionation had split up this stable molecular group into its components, distributing its atoms into several groups, with different phosphorescent spectra.

No longer than twelve months ago the name yttria conveyed a perfectly definite meaning to all chemists. It meant the oxide of the elementary body yttrium. I have in my possession specimens of yttria from M. de Marignac (considered by him to be purer than any chemist had hitherto obtained), from M. Clève (called by him "purissimum"), from M. de Boisbaudran (a sample of which is described by this eminent chemist as "scarcely

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[1] A Paper read before Section B of the British Association at the Birmingham meeting, by William Crookes, F.R.S., V.P.C.S