THURSDAY, SEPTEMBER 25, 1884

MODERN STEAM PRACTICE AND ENGINEERING

Modern Steam Practice and Engineering. By John G. Winton, assisted by W. J. Millar, C.E. (London: Blackie and Sons, 1883.)

THE want has long been felt by those employed in the engineering works of this country of a book which shall serve as a guide to the various operations in the workshop, giving a practical yet concise description of the various methods employed, and the reason for using any particular method. In some works we find the business conducted in an old-fashioned stereotyped way, and in others all the latest improvements are introduced. The number of workmen who can give the real reason for using any particular method is very small, the reason generally gi. ~ being, "The work has always been done that way?" I. is here where the apprentice finds one of the many difficulties he has to overcome; he can see the work done, but cannot fathom the reason for doing it any particular way; his foreman perhaps being too busy to help him, he has to do the best he can.

The volume before us will go a long way towards solving this difficulty. The author, being a practical man, treats the subject in a thoroughly practical way, using the technical language of the shops, thereby making the various descriptions and plates throughout the volume exceedingly clear. At the same time the higher principles involved in the various machines described are not overlooked, so that it is also a valuable book of reference in the drawing office, as well as a useful companion to those who have charge of men engaged in the various branches of mechanical engineering. For students attending the workshops and classes of the various engineering colleges it will be found to be very useful, giving as it does a *practical* description of the work, and helping considerably to get that knowledge which can alone be got in the workshops of the country.

The book is divided into five sections, subdivided into chapters.

Section I. is on the boiler and steam, commencing with a short chapter on coal and coal-mining. The author gives a short account of the troubles of the miner, and tells us of the methods in use for lining the shafts. Ventilation is dealt with; the various exhaust fans are next mentioned, with an illustration of the gimbal fan; then the author goes on to the usual methods for getting the coal. The chapter is a very appropriate commencement to the volume, although it gives a rather short account of the coal-mining industry.

We then come to a long chapter on stationary boilers, giving a good description of the various types in use. We miss the Lancashire boiler, with its two flues and conical water-tubes, from the illustrations. The author discusses the strength of riveted joints, giving the results of some experiments. We should have liked to find here a short account of the important researches on the strength of riveted joints carried out by Prof. Kennedy at the Engineering Schools of University College, London. The strength of cylindrical boilers is gone into fully, the various strains tending to rupture the plates are pointed out, and tables are given showing the proper thickness of plates for the different diameters. It is impossible here to give anything like a complete *résumé* of this chapter, no pains having been spared to get together as much information as possible; the author has succeeded in making it one of the most useful chapters in the work. He goes on to the foundations and settings for the different types of boiler, giving an account of the dimensions for the chimney. Smoke prevention is discussed, the conclusion at which the author arrives being thus stated: "We unhesitatingly give as our opinion that unless the attendant sees that the furnace is kept in proper trim, firing with the least quantity of coal, ofttimes replenished, all the refinements for the prevention of smoke will not attain the desired object, for careful firing is the main secret to arrive at."

Boilers for marine purposes are dealt with in a similar manner, the various types being discussed and illustrated. The arrangement of boilers for ships of war is gone into, high-pressure boilers having a fair share of the text. The proportions of marine boilers are treated, and suitable rules given for calculating the various dimensions, the chapter concluding with an illustration of the boilers of the s.s. *Parisian*, of the Allan Line of Atlantic steamers.

After showing the various methods for superheating and drying the steam by means of superheaters, both tubular and cylindrical, the author explains the methods of manufacture of boilers, more especially the best arrangement of plates and angle iron, and the staying of flat surfaces. We agree with the author when he says that this subject closely affects the interests of steam users, and the extract from a report of the National Boiler Insurance Company is well worth studying. Section I. concludes with the regulation and expansion of steam. The action of the slide valve is thoroughly explained, and the benefits derived from lap and lead pointed out. The different arrangements of the link motion are illustrated and clearly explained, then equilibrium slide valves are discussed and the arrangements clearly illustrated. The action of the indicator and the mode of driving the roller cylinder is shown; some very good examples of indicator diagrams taken from simple and compound engines are given; the section closing with a short chapter on the expansion of steam, with tables of hyperbolic logarithms, and the properties of saturated steam at different pressures.

Section II. is entirely devoted to stationary engines, commencing with the Cornish pumping-engine, afterwards dealing with the several different types of pumping-engines,—as pumping-engines for water-works, drainage works, and general purposes. The reader will here grasp the immense amount of trouble the author has taken to get all the information together, down to the smallest detail; each class of engine being well illustrated, its leading features pointed out, and the explanations of the different parts being very clear. Nor are the underground appliances overlooked, the pumps, valves and other parts in connection with the gear are thoroughly described and illustrated.

Pumping-engines for water-works are very similar to those used for draining mines. We have several good examples; the description of the Tottenham pumping-engines is very interesting; and we have another example in the engines of the Berwick-on-Tweed Waterworks.

Of pumping-engines for drainage purposes, the London drainage system furnishes perhaps the best possible example; the Abbey Mills pumping-station with its eight engines giving an aggregate of 1140 horse-power, capable of dealing with 15,000 cubic feet of sewage per minute, lifting it 36 feet high; the Deptford pumping-station, with a horse-power of 500, lifting 10,000 cubic feet of sewage per minute to a height of 18 feet. The pumping-engines at Crossness are also described, having a collective horse-power of 500, dealing with 10,000 cubic feet of sewage per minute, with a varying lift of from 10 to 30 feet according to circumstances.

After a short account of an arrangement of centrifugal pumping machinery, the author deals with winding engines, giving a clear description of this class, and as an example we have a full-page engraving of an engine for the Benhar Coal Company, by Messrs. Gibb and Hogg, Airdrie.

The various types of blowing-engines are described; afterwards rolling-mill engines, having as examples some engines erected at the Dowlais Ironworks, and compound reversing rail-mill engines at the Hallside Steel-works, near Glasgow: these latter are shown in a full-page engraving and are fully described in the text.

Under water-pressure engines we find the accumulator and charging pumps illustrated, the hydraulic crane, and the usual hydraulic machinery for dock gates is described, the section concluding with an account of the hydraulic machinery for warehousing grain at the Liverpool Docks and a full-page engraving of hydraulic machine tools, designed by Mr. R. H. Tweddell.

In Section III. we have the marine engine thoroughly and completely explained. We here see what a tremendous advance has been made in the science of marine engine building, the engines of the latest additions to our mercantile navy being nearly theoretically perfect as far as the economical consumption of steam is concerned, and the proportions of the different parts more in accordance with the individual strains they have to withstand. The author treats the subject fully, each part and detail being illustrated, and reasons given for any peculiarity of construction in the engines described; he then goes on to screw propellers, and kindred appliances, the section concluding with a full-page engraving of the compound engines of the steam-ships *Servia* and *Parisian*, the descriptions being very clear and to the point. Rules for the horizontal marine engine finish the section.

Perhaps the locomotive engine, which is treated in Section IV., has advanced by greater strides than any other machine within the last twenty years, the reasons being that the traffic on the railways has got heavier, competition has forced the companies to run the trains at higher speeds, at the same time that the vehicles composing the trains have increased both in size and weight.

This increase means that the engine must have a higher tractive power, which can only be got by increasing the weight on the driving-wheels; larger cylinders must be used, and consequently a larger boiler and fire-box for the increased consumption of steam. As an example of an express passenger locomotive of the present day, we may take the engines designed by Mr. Stirling for the Great Northern Railway, having driving-wheels 8 feet in diameter, cylinders 18 inches in diameter with a stroke of 2 feet 4 inches. Compare these engines with one built fifteen or twenty years ago, and the marvellous change will be at once apparent.

The author commences the section with a variety of fire-boxes designed to consume the smoke when burning coal, some being very complicated. All locomotives of the present day burn coal, and from the very complicated fire-boxes illustrated, the fire-box has resolved itself into a perfectly plain box, having a brick arch, to mix the products of combustion previous to their passage through the tubes. This when fired properly is quite capable of consuming all the volatile hydrocarbons in the coal without the formation of any smoke.

The illustrations in the earlier part of the section are somewhat old-fashioned; the one showing the stays inside a locomotive boiler might have been of more recent design. We remember having seen a boiler of the same type on a locomotive built in 1847. With this as the only drawback, the section treats the subject in a clear and practical way; we do not know of any work in which one can find so much information.

In the description of the American locomotive, one finds many arrangements which look strange to those accustomed to English practice, but we cannot notice any peculiarity which we think could be adopted in this country with advantage. After a short account of the different classes of automatic continuous brakes, in which the Westinghouse and vacuum automatic brakes are discussed, we have some very good examples of the latest locomotive practice of this country. The engraving showing the vertical and horizontal sections of a bogie passenger engine, for the Caledonian Railway, is very clear, and the description good. Afterwards we find engines for the Great Northern, London and North-Western, and North British Railways thoroughly and clearly discussed, the general constructions being explained. The section concludes with a specification for a bogie locomotive, designed by Mr. William Kirtley for the London, Chatham, and Dover Railway, and a set of rules are compiled for the construction of locomotives.

In Section V. there is a very interesting and useful account of the construction of iron ships. The section of necessity treats the subject generally, the scope of iron shipbuilding being so large. The transverse and longitudinal methods of construction are explained, an account is given of the late Mr. William Froude's experiments with ship models, and as an example of recent practice we have the longitudinal section and deck plans of the s.s. *Orient*, with a concise description of her construction; afterwards the rigging is explained, with illustrations of the sparring and sail plan of a full-rigged ship. Then comes a short account of armoured war-ships, with a description of H.M.S. *Polyphemus*, the section concluding with dredgers, and examples of specifications for iron ships to Lloyd's rules.

Under the head of engineering works, the author gives a description of floating docks, the construction of iron roofs, the construction of, and strain on, wrought-iron girders. There is a very clear analysis of the strains on the struts and ties in the lattice girder; the construction and sectional area of each strut and tie is worked out; next the suspension bridge is discussed, the general construction being explained.

The last few subjects treated in the volume include the fire-engine and gas-engine, with several other short accounts of the newest inventions, concluding with a chapter on the strength of materials.

In the publishers' preface we read that the present work is intended to furnish a reliable guide to practical engineers and others connected with the engine-shop and building-yard. This end has been most satisfactorily accomplished, and both authors and publishers may be congratulated on having placed before the public a most useful book; the printing is exceedingly clear, and the illustrations in the text good; the separate series of engraved plates add much to the value of the volume, without which many long descriptions would have been necessary. The book deserves a place in every technical library in the country. Those learning any branch of mechanical engineering will do well to study it, for it is one of the few really practical works published.

OUR BOOK SHELF

Catalogue and Handbook of the Archæological Collections in the Indian Museum. Part II. By John Anderson. (Calcutta.)

WE have already drawn attention to the first part of this excellent Catalogue, which thoroughly fulfils its promise of being not only an exhaustive list of the valuable objects in the Indian Museum, but a scholarly guide to them as well. The second part is occupied with Buddhist, Jain, Brahminical, and Mohammedan sculptures, and with the collections from Southern India, Persia, and other parts of the East. Appendixes have been added at the end of the book, including two by Prof. Warden and Mr. Growse. The work will be of great value to students of Indian archæology, and more especially to those who are devoting themselves to Buddhistic research. The Indian Museum is naturally a storehouse of antiquities throwing light on the past history of India and its relations with the West, and these have now been brought to the knowledge of scholars in a thoroughly satisfactory way.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Barnard's Comet

LAST night (September 22) this comet was well seen in the 3-foot telescope. It was large (at least 4′ over), brighter to the middle, but without nucleus; a position was measured from a faint star involved in the light of the head. At 8h. 20m. the position by circle reading was *a* 19h. 45m. 50s., and 117° 16′ 30″ N.P.D.

A. A. COMMON

Ealing, September 23

The Krakatoa Eruption

BY this morning's post I have received, in a rather roundabout way from India, a translation of a Dutch account of the Krakatoa eruption, which, if you have not had it already, seems to contain some interesting variations on, or additions to, the mass of matter that you have already printed on that subject. Indeed the only postscript that could now be well added to it is the comfortable and encouraging discovery of the late French scientific expedition to the effect that the eruption is now positively over. The Batavians, as you are probably aware, feared that another eruption was preparing, in consequence of the immense number of stones still being ejected and clouds of smoke emitted. But the French *savants* discovered that no stones were being thrown up, only immense quantities of them tumbling down the mountain's sides; and this because the material, of which those new sides of the mountain are now composed, is so extraordinarily friable that the heat of the sun each day breaks them up, and the quiet force of gravitation brings the pieces galloping down the steep slopes, and plunging at last into the sea, to the danger of passing vessels,—but only by day, and when the sun is shining, for at night everything is quiet; and if by day and night a cloud forms above the mountain-top, it is neither smoke nor gaseous emanation, but merely the infinitely fine powdery matter of the broken-up and rolling stones of the day rising into the air and moving along with its currents up along the slopes which have been warmed by the sun.

C. PIAZZI-SMYTH

15, Royal Terrace, Edinburgh, September 15

The Sky-Glows

I WAS not aware before reading Mr. Leslie's letter in NATURE of the 11th inst. (p. 463) that any of the phenomena supposed to be connected with the volcanic dust had been seen before the eruption of Krakatoa in May 1883. Would the whole text of the description of those seen in February 1883 in Natal, from which Mr. Leslie gives a quotation, indicate them to be exactly similar to those seen since the great eruption? Where can a description of them be found?

The remarkable suusets reported as seen in Mauritius after May 1883 and before the great eruption of Krakatoa, were by some attributed to the earlier volcanic disturbance, while others have expressed doubts whether they were really similar to those so generally noticed last autumn and winter.

It was not in the least the purpose of my former letter to imply the necessity of visiting a mountainous country to see the red corona round the sun; I am aware it is still plainly visible in England, and do not doubt even in London in fairly clear weather, having observed it when there in May last, not only within an hour of sunset or sunrise, but at all times of the day. But I wished to draw your readers' attention to the fact that this corona is much better seen in the clearer air at great altitudes, where also it is not necessary, as in England, that the sun be hidden by a cloud for it to be well seen.

I had not seen it stated before that the phenomena have been visible in England for years past. There is much more to be seen than a "blanching of the sun," as Mr. Leslie calls it, so that perhaps we are not both discussing the same phenomenon. Besides the bluish or greenish light immediately round the sun, which is not very striking, there is a broad red or brown band beyond, which is so. Has this been seen in England previous to last November? It has been habitual for me to scan the neighbourhood of the sun for halos during twenty-five years, and I never observed it previously to the date mentioned. It is true that the circumstances favourable for producing halos are unfavourable for seeing the red ring; nevertheless, since the latter first appeared in November I have not unfrequently seen it at the same time with a halo. It is also true that I saw portions of this red ring some days before I recognised them as a new phenomenon, but then they were only visible in gaps between clouds, so that I took them to be on thin cloud, and simply examples of the nacreous hues of thin films; any large extent of sky would probably have enabled me to perceive their true character. It is therefore very difficult for me to believe that the corona was visible in this country much, if at all, before last November.

Whether the phenomenon is ordinarily noticeable in volcanic countries I have not learnt; information from observers in such places would be of much value towards the elucidation of this interesting question. I gather from Prof. G. H. Stone's statement (NATURE, vol. xxix. p. 404) that a somewhat similar appearance is commonly visible in Colorado, where it may perhaps be attributed to the higher layers of dust of that very dusty region.

T. W. BACKHOUSE

Sunderland, September 20

THE glowing sunsets having reappeared, though far less brilliant than in November and December last, I send you a list of the most remarkable of them which have been noticed at Clairvaux, in the Department of Aube. They appeared with the same features as have been so often described in NATURE, and were especially glowing on the following days:—November 25, 27, 28; December 12; January 7, 12; August 6, 22 (feeble, sky not quite bright), and 23 (more brilliant); September 10 (feeble, bright sky, beautiful pink coloration in the east) and 17 (bright sky, bright pink coloration one hour after sunset). When the sky is bright, the rise of the moon is preceded, for nearly one hour, by a bright illumination of the sky.

Clairvaux, Aube P. K.

FOR the last four evenings, the 15th, 16th, 17th, and 18th, and again to-night, the colour of the sky from 20 to 25 minutes after sunset has taken that deep magenta glow looking very like the effect of a great fire, only lighter in tone. Last night, the 18th, this lasted until after 7 o'clock, and stars were then shining through it as they do through an aurora.

The reappearance of these glows was to be expected, as the haze and ruddy glow about the sun by day has, so far as I have been able to see, never really been long absent since attention was first drawn to it last autumn. I have now received a letter from Sydney, dated July 24, in which the writer says: "Since we have been in the Southern Hemisphere the sunsets have certainly had more striking colours, and on many occasions I have seen that peculiar magenta or mauve tint in the sky like aurora, only bluer in colour, while the sky has been very white just before sundown." The writer of the above is used to the look of the sun and sky, being an officer on board a mail steamer. I had suspected that absence of colour more or less in the sunsets here during our summer might be owing to the position of the sun rather than to any diminution in the quantity of vapour in the higher atmosphere, and had asked the writer of the above to note as he went south, in their winter, whether there was any increase in the colour of the after-glows, &c., being led to think this might be the case from reading the report of Mr. Neison, Director of the Natal Observatory, in which he speaks of having "first observed these phenomena in February 1883, from which time they increased in intensity until June, after which there was an interruption until the month of August." This led me to expect a return of strongly marked colour in our after-glows in autumn, increasing probably in intensity and duration during our winter months, when the weather is clear enough to see the sky. ROBT. LESLIE

Moira Place, Southampton, September 19

The Diffusion of Species

THE vast and altogether exceptional assemblage of Salpæ mentioned in NATURE (September 11, p. 462) by the Duke of Argyll as having been observed by him whilst recently cruising in the Hebridean seas, was due, in all probability, to the extension in a north-easterly direction of the ordinary surface-current of the Atlantic, or to an unusually long continuance of steady south-westerly wind, the effect of which would be to drive the superficial water of the Atlantic before it to the British coasts, and, with the water, the enormous multitudes of Salpæ which are occasionally to be met with in the latitude of the Canaries and Cape Verd Islands.[1]

During voyages to and from Bengal, *viâ* the Cape, in the good old days of sailing vessels, I repeatedly came across vast aggregations of these creatures, my attention having been specially called to them whilst engaged as I generally was for many hours by night as well as by day, in using a towing net from the stern ports for the capture of natural history specimens.

On my last voyage from Bengal in 1857 the ship sailed through some fifty or sixty miles of what the Duke aptly describes as Salpa soup, and which looked exactly like boiled tapioca. The quantity of Salpæ present in a bucket of the sea-water was, at least, equal in volume to the volume of water, but then the bodies of the Salpæ themselves consist in reality of more than 90 per cent. of water. On the occasion referred to, almost the entire mass consisted of a small species of Salpa about an inch in length, but nevertheless large enough to render the bright yellow digestive cavity of each, which is about the size of the smallest pin's head, distinctly visible. This was invariably full of certain species of oceanic diatoms the endochrome of which imparted the yellow colour. It is worthy of remark that in the case of the Salpæ, as well as many other organisms holding a yet lower position in the animal scale, there undoubtedly exists a selective power which enables them to pick out certain kinds of food in the midst of a superabundance of different kinds.

In the tropical Atlantic and Indian Oceans also I have seen, during calms, immense numbers (though not to be compared with the gatherings of the smaller Salpæ) of the larger chain Salpæ. These sometimes attain a length of from 8 to 10 inches, and have stomachs as large as a good-sized marble or hazel-nut.

But the most interesting assemblage of the lower forms of pelagic life was noticed by me about 200 miles from Ceylon, during a dead calm of four days' duration, when the sea was as smooth as a mirror, and undisturbed save by its never-ceasing majestic swell. Deep down, as far as the eye could penetrate, were to be seen numbers of brightly coloured water-snakes, delicately tinted "Venus's girdles," "Velellæ," and countless multitudes of those more minute living things which, though barely visible as mere specks to the unaided vision, are full of beauty and interest when observed under the microscope. Such a calm is a veritable pandemonium to the "skipper,"—to the naturalist it is a paradise. G. C. WALLICH

September 14

[1] As is well known, vast assemblages of Salpæ and kindred forms constantly occur at the surface in Arctic and Subarctic seas during the prevalence of moderate weather.

I AM specially interested in the Duke of Argyll's letter on the above subject (p. 462), being a resident during nearly half the year in the most southern of the Hebrides. His Grace is so competent a naturalist, and so accurate an observer, that I assume at once he had evidence which satisfied himself that an adder swam from Mull to Iona. Still I must be pardoned if I say that your readers have not been supplied with the proofs which have satisfied his Grace. A boy and girl in Iona, who, I presume, had never seen an adder in their lives, killed a creature in the sea there. Might it not have been an eel?

As regards distribution of species I may mention the following. In this island (Islay) we have multitudes of *stoats* but not a single *weasel*, while I am informed on trustworthy authority that in the neighbouring island of Colonsay there are many weasels but not a single stoat. R. SCOT SKIRVING

Sunderland House, Islay, September 18

Shifting of the Earth's Axis

IN the very interesting address of Prof. Young (NATURE, September 18, p. 501) he refers to the variability of the earth's axis, and states that a change of 1″ per century has been detected at Pulkowa, but that "the Greenwich and Paris observations do not show any such result." Now only last year, in the "Pyramids and Temples of Gizeh," I had (p. 126) noted that the Greenwich observations *did* appear to show a change, and that a change of the same amount and same direction as is stated by Prof. Young for Pulkowa; the observations of this century showing a decrease of 1″ of latitude per century, or with those of Maskelyne a decrease of 1″·38 per century.

This change I adduced as corroborating the result shown by four very accurate orientations of the earliest buildings, the Gizeh pyramids. These structures, whose errors are but a few seconds of angle, agree in standing as much as 4′ or 5′ to the west of the present north. This would imply a change of about 5″ or 6″ per century in the direction of long. 120°; a result quite comparable to the motion of 1″ or 1″·4 per century in long. 0° and 30°. Such a change might be effected by causes which are beyond our observation; as, for instance, unbalanced ocean circulation equal to a ring of water only 4 square miles in section moving at a mile an hour across the poles. If this motion of 6″ per century in long. 120° is still in action, we might now expect to find a change of about 5″ in the meridian determined at the beginning of the Ordnance Survey, a ground of observation which should not be neglected. W. M. FLINDERS PETRIE

Bromley, Kent

Salmon-Breeding

MR. FRANCIS DAY's interesting communication last week (p. 488) on this subject is likely to attract more attention from biologists and pisciculturists than any other recently-ascertained fact in the natural history of the Salmonidæ, and it opens the large question how the migratory instinct became established in certain members of the family, when it appears not to be physiologically indispensable to them. At the period of migration, when the smolts are fit to go to the sea, they evince, I believe, the utmost restlessness (like all migratory animals), and frequently leap out of the fresh water in which they are confined, and die on the banks. This has taken place year after year in the nursery ponds on the Plenty River, Tasmania, where it was first placed beyond question that a migratory salmonid could remain and breed perfectly freely year after year in fresh water. On January 20, 1866, Mr. J. A. Youl, C.M.G., sent out to Tasmania a consignment of salmon, salmon-trout, and brown trout (*S. fario Ansonii*). On June 25, 1869, several parrs of the salmon-trout, then weighing in some instances more than a pound, were busy nesting, the result being that many thousands of fry from their ova were subsequently sent to stock other rivers. The imprisoned salmon-trout have continued to breed for several years in succession, but there has been noticed in them a tendency to become sterile as they grow older. There is also some reason to believe that *Salmo salar* has bred in the ponds on the Plenty. Two young specimens which, from certain circumstances, the Commissioners believed to be true salmon, were sent to Dr. Günther for examination, with full information as to their origin and history; and he, while expressing his reluctance to give a decided opinion, stated that they "presented all the anatomical characters of *S. salar*." Full details of the breeding in fresh water of *S. trutta* will be found in "The Acclimatisation of the Salmonidæ at the Antipodes—its History and Results." ARTHUR NICOLS

A Sea Monster

A FRIEND of mine, Capt. W. Hopkins, of the schooner *Mary Ogilvie*, who has just returned from a voyage all round Australia, has given me the following information, which I forward you for publication, not so much because of its interesting character, but in order that other travellers may throw some light upon the character of the animal, which, if an Octopus, must be of much larger dimensions than those usually met with. On June 15, when in S. lat. 21° 37′ and E. long. 113° 49′, about five miles off the Exmouth Gulf on the western coast of the continent, he saw an immense creature which he took to be a species of Octopus. His attention was drawn to it by a perfect cloud of sea birds, and at first he naturally thought it must be a dead carcass. On approaching it, however, he found it was alive, and sluggishly disporting itself. In shape it was like a violin, but of immense size, with some six feelers about the greater diameters of the violin. It lay almost flat upon the water, was of a dark gray above and lighter gray below, and was continually elevating one of its feelers, apparently twice the thickness of a man's arm, to a height of from six to eight feet. It appeared to be vomiting, and as the birds were evidently feeding, that accounted for their presence in such numbers. Its size was so great that, had it grasped the vessel, it could easily have capsized it. The captain therefore got out of the way as quickly as possible, and without making definite measurements; but a large whale in the vicinity looked quite diminutive. It is a pity that something more exact as to size is not available, but I think the description is sufficient to convey an idea of the nature of the monster. All along the northern and western coasts of the continent vast shoals of pumice, in portions varying in size from ordinary gravel to about a foot in diameter, and completely covered with barnacles, were passed through.

Sydney, N.S.W., August 4 ALFRED MORRIS

Hail

WILL any of your readers kindly oblige me with particulars of the formation of a hailstone, and the effect produced upon it by falling through the air. How does it become frozen? increase in size? and what are the conditions for its increase? up to what point in its passage does it increase? what effect has temperature upon it in its downward career? after a certain point in its fall should it not theoretically decrease in size? does it do so actually? how is it that larger stones generally fall in tropical or hot climates during thunderstorms than we witness during our English winters? Does a raindrop increase in size as it nears the earth? If so, please give reasons. A. D.

Lisbon, September 1

[The best account of the formation of hail is given in Ferrel's "Meteorological Researches for the Use of the Coast Pilot," Part II. p. 85, a brief *résumé* of which is given in the "Encyclopædia Britannica," article *Meteorology*, p. 132.—ED.]

THE "COMMA-SHAPED BACILLUS," ALLEGED TO BE THE CAUSE OF CHOLERA[1]

WITH a view of studying the phase which the cholera question has now entered upon, in consequence of the publication of the results of the investigations of the German Cholera Commission in Egypt and India, I availed myself of the opportunity which the present vacation at the Army Medical School afforded of proceeding to Marseilles, where the disease has been prevalent since the end of June. Sir Joseph Fayrer was so kind as to enlist for me the valuable assistance of Dr. Le Roy de Méricourt, Médecin en Chef of the French Navy, who in various ways did his utmost to further my wishes. Dr. Marroin, the Chief of the Sanitary Department in Marseilles, was so good as to introduce me to the authorities of the Pharo Hospital, where the cholera cases are treated, and where, with the permission of the principal medical officer, Dr. Trastour, I was able to renew my acquaintance with the disease, and to collect material for studying afresh the microscopy of the intestinal discharges.

Before, however, referring to the results of my own observations, it will be convenient to epitomise the published history of the German Commission; to point out the salient features of the results of their investigations in Egypt and in India; and to make a few brief comments on such of the circumstances and conclusions as appear to call for notice. Shortly after the arrival of the Commission in Egypt, Dr. Robert Koch reported, on behalf of himself and his colleagues, that no special micro-parasites had been discovered in the blood, the lungs, the spleen, the kidneys, or in the liver in cholera, but that the intestinal mucous membrane was permeated by certain Bacilli which nearly resembled in size and form the Bacilli found in glanders. As is well known, these Bacilli are straight, and are, in fact, uncommonly like the ordinary microphytes associated with decay. Dr. Koch also states in connection with this subject that he had, previous to proceeding to Egypt, found similar Bacilli in the intestinal mucous membrane of four natives of India, but that he had then looked upon them as due to merely *post mortem* changes. When he came to Egypt, however, and found these same Bacilli in the intestines of perfectly fresh cases, he felt that an important link was furnished towards establishing the identity of the disease in Egypt with Indian cholera.

It is highly probable that the specimens from India which Dr. Koch had examined were those which were sent, at the request of the Imperial Health Department in Berlin, by the Sanitary Commissioner with the Government of India. These consisted of numerous dry cover-glass specimens of blood which I had collected from several cholera patients, and of portions of the viscera of four natives who had died of the disease. All these were examined by me before they were despatched, and portions of each were reserved for further study. I had heard nothing further of them, but the publication of the remarks above referred to in Dr. Koch's Report of September 17, 1883, from Alexandria, recalled them to my mind, and I was glad to infer that my own negative results had been confirmed in Berlin. As already observed, no importance had been originally attached to the organisms which were present in the intestinal mucosa. During the last six months I have examined hundreds of stained microtome-sections of these four, and of other specimens of cholera intestines in my possession, and have found that, when the mucosa is infiltrated with

[1] A Memorandum by Surgeon-Major Timothy Richards Lewis, M.B., Assistant Professor of Pathology, Army Medical School. Communicated by the Director-General, Army Medical Department.

microphytes at all, they are either Micrococci, Bacteria, or long-oval, and straight Bacilli.

In the Report of the Commission, dated Calcutta, February 2, 1884, Dr. Koch, however, announces for the first time that the specific Bacillus of cholera is curved or comma-shaped, and not straight; so that apparently it had become necessary to abandon the microbe first fixed upon. Assuming that the four specimens from natives of India which had been examined by Dr. Koch were those which passed through my hands, the evidence they furnish seems to be in accordance with this view, as in not one of them have I been able to detect any invasion by unmistakable "commas," though at least one of the specimens may fairly be characterised as abundantly infiltrated (in the manner described by Dr. Koch) by straight (and as I prefer to call them) putrefactive Bacilli. Judging from my own experience, therefore, any extensive infiltration of the intestinal mucous membrane in cholera by comma-shaped Bacilli must be exceedingly rare; and this, I believe, is likewise the experience of the members of the late French Cholera Commission, MM. Straus, Roux, and Nocard, whose acquaintance I had the pleasure of making at M. Pasteur's laboratory on my return through Paris.

Whilst at Marseilles I had, as already stated, opportunities of observing numerous specimens of choleraic excreta, and found that comma-shaped Bacilli were, more or less conspicuously, present in all of them, though in some instances more than one slide had to be examined before any could be satisfactorily detected. It may also be mentioned that some of the discharges in which these organisms were present manifested an acid reaction when tested with litmus paper. As Dr. Koch himself remarks, the proportion which the comma-shaped Bacilli bear to other organisms in the dejecta varies greatly. In some instances only one or two specimens are to be found in the field of the microscope, while in others they are very numerous, and Drs. Nicati and Rietsch (who are at present engaged in the study of the disease at Marseilles) were so kind as to show me a specimen of choleraic material they had obtained from the small intestine, in which the "commas" existed almost to the exclusion of all other organisms. This is a condition, however, which, I understand, is exceedingly rare. On the other hand, I have seen samples of choleraic dejecta in which totally different organisms prevailed to a like exclusion of others; and in one instance at Marseilles spirilla of various sizes and forms were the most conspicuous of the micro-organisms present. So far, therefore, the selection of the comma-shaped Bacilli as the *materies morbi* of cholera appears to be entirely arbitrary.

Dr. Koch and his colleagues have adduced no evidence to show that they are more pernicious than any other microbe; indeed, as a matter of fact, the sole argument of any weight which has been brought forward in favour of the comma-shaped Bacillus being the cause of cholera, is the circumstance that it is more or less prevalent in every case of the disease, and that the German Commission had not succeeded in finding it in any other. With regard to the suggestion that the cholera process may in some way favour the growth of these Bacilli, and that these are not necessarily the cause of the disease, Dr. Koch remarks, in the Report from Calcutta above cited, that such a view is untenable, inasmuch as it would have to be assumed "that the alimentary canal of a person stricken with cholera must have already contained these particular Bacteria; and, seeing that they have invariably been found in a comparatively large number of cases of the disease both in Egypt and India—two wholly separate countries—it would be necessary to assume, further, that every individual must harbour them in his system. This, however, cannot be the case, because, as already stated, the comma-like Bacilli are never found except in cases of cholera."

Had Dr. Koch and his colleagues submitted the secretions of the mouth and fauces—the very commencement of the alimentary canal—to a careful microscopic examination of the same kind as that to which they have submitted the alvine discharges, I feel persuaded that such a sentence as the foregoing would not have been written, seeing that comma-like Bacilli, identical in size, form, and in their reaction with aniline dyes, with those found in choleraic dejecta, are ordinarily present in the mouth of perfectly healthy persons.[1]

There is no difficulty in putting this statement to the test; and to any one acquainted with the methods ordinarily adopted for staining and mounting fungal organisms of this character, no special directions need be given. The procedure followed by me to demonstrate these "commas" in the saliva is precisely that adopted for finding them in the dejections. A little saliva should be placed on a cover-glass (preferably in the morning before the teeth are brushed) and allowed to dry thoroughly, either spontaneously or aided by a gentle heat. The dry films thus obtained should be floated for a minute or two with one or other of the ordinary solutions of aniline dyes adopted for such purposes, such, for example, as fuchsine, gentian-violet, or methylene blue. The cover should then be gently rinsed with distilled water, and the film re-dried thoroughly. The preparation may now be mounted in dammar varnish or Canada balsam dissolved in benzol, and should be examined under a 1/12th or 1/16th of an inch oil-immersion lens.

As in choleraic discharges so in the saliva the number of comma-shaped Bacilli will be found to vary greatly in different persons, and at different times in the same person. Sometimes only one or two "commas" will be seen in the field, at others a dozen may be counted, and, occasionally, little colony-groups of them may be found scattered here and there throughout the slide.

It may be remarked in passing, and as bearing upon what has been already said regarding the general absence of comma-shaped Bacteria from the intestinal mucosa itself, that they do not appear to manifest any special tendency for attacking the decaying epithelial scales of the mouth, but that, on the contrary, they are for the most

[1] Since this Memorandum was submitted, I have observed that Dr. Koch states, in his recent address on the subject, that, after his return to Berlin he had examined, amongst other things, the secretions of the mouth for comma-shaped Bacilli, but had found none; and, further, that he had consulted persons of much experience in bacterial researches as to whether they had ever seen such organisms, and was told that they had not.

It may be of assistance to future observers if I give the dimensions of half-a-dozen comma-shaped Bacilli as found in each of the following:—(*a*) In the alvine discharges of three cholera-affected persons; (*b*) in the small intestine of a person who had died of the disease and in whom they existed almost to the exclusion of other organisms; (*c*) in a cultivation of them in Agar-Agar jelly; and (*d*) in the secretions of the mouth of three healthy persons, ranging from four to fifty years of age. The measurements were made (with the valuable assistance of Mr. Arthur E. Brown, B.Sc. Lond.) under a magnifying power of 1000 diameters—a Powell and Lealand's 1/16th of an inch oil-immersion lens, with a wide angle condenser, being used.

LENGTH AND WIDTH (IN MICRO-MILLIMETRES *) OF COMMA-SHAPED BACILLI IN CHOLERAIC MATERIAL

Nos.	Alvine discharges I.	Alvine discharges II.	Alvine discharges III.	Intestinal contents (autopsy)	Cultivation in Agar-Agar jelly
	μ μ	μ μ	μ μ	μ μ	μ μ
1.	2·4×0·40	2·0×0·60	1·1×0·25	2·0×0·40	1·6×0·40
2.	2·6×0·40	2·5×0·65	1·8×0·35	1·2×0·40	1·4×0·60
3.	2·0×0·50	3·2×0·70	2·0×0·60	1·5×0·45	1·8×0·50
4.	2·2×0·45	3·0×0·70	3·0×0·70	1·3×0·60	2·0×0·50
5.	2·8×0·35†	2·5×0·60	2·2×0·50	2·1×0·50†	2·6×0·45†
6.	1·5×0·35	2·0×0·50	1·6×0·40	1·2×0·50	1·1×0·35

LENGTH AND WIDTH (IN MICRO-MILLIMETRES *) OF COMMA-SHAPED BACILLI IN SECRETIONS OF THE MOUTH IN HEALTH

Nos.	I.	II.	III.
	μ μ	μ μ	μ μ
1.	2·0×0·50	1·4×0·35	1·5×0·50
2.	1·3×0·35	2·0×0·40	1·3×0·50
3.	1·6×0·40	1·7×0·40	1·0×0·30
4.	1·2×0·35†	1·3×0·45	1·2×0·40
5.	2·2×0·65	2·1×0·50	2·1×0·50
6.	2·0×0·40	2·8×0·40†	1·4×0·55

* One micro-millimetre (μ) = ·001 millimetre (= 1/25,000″).

† *s*-shaped comma-bacilli.

part found free in the fluid, the epithelium being studded with other bacterial forms.

Persons who have not been in the habit of examining dried saliva-films will probably be surprised at the number and variety of the organisms which are, more or less, constantly to be found in the mouth; and especially at the number of spirilla with which the fluid is generally crowded.

The alvine discharges in cholera sometimes swarm with precisely similar spiral organisms, and, indeed, as has long been known, the fluid exuded into the intestines in this disease is peculiarly suitable for the growth of these and allied microbes. But, so far as my own experience—dating from 1869—of the microscopic examination of such a fluid goes, all the microphytes ordinarily found in it are likewise to be found, to a greater or less extent, in the secretions of the mouth and fauces of unaffected persons. And with reference to the comma-like Bacilli found in cholera, to which such virulent properties have been ascribed, I shall continue to regard them as identical in their nature with those ordinarily present in the saliva until it has been clearly demonstrated that they are physiologically different.

Pathological Laboratory, Netley, September 1

FORESTS IN COBURG, GERMANY, AND RUSSIA

A BLUE-BOOK under the title of "Reports by Her Majesty's Representatives abroad on the Cultivation of Woods and Forests in the Countries in which they reside," has just been published by Messrs. Harrison & Sons. These Reports are of an extremely interesting character, and we gladly draw attention to them, appearing as they do at an opportune moment before the close of the Forestry Exhibition at Edinburgh.

The Reports come from Coburg and Gotha, Germany, Norway, Russia, and Sweden, and in the form of an appendix is a *précis* by Dr. Lyons, M.P., of the Reports on Forestry of the United States Department of Agriculture. In each one of these Reports much valuable information is given and information of a very varied character. Thus in the first we are told that the forests in Gotha consist of 85 per cent. of pine and 15 per cent. of other wood. The principal timber-trees are pine and beech, whereas the remaining sorts of wood, namely Scotch fir, spruce, larch, oak, maple, ash, birch, and elm are found only in small quantities or mixed with the other species. The period during which the different woods are gradually brought into use is such that pine forests and mixed forests shall yield as large an amount as possible of saleable timber, whilst in the beech woods the greatest amount of wood as fuel is sought without allowing the trees to attain an age at which they would no longer pay the interest on the value of the soil. Pine and beech wood in higher situations are, according to these principles, usually cultivated and worked in cycles of one hundred years, while spruce on the lower heights and in the plains are worked on an eighty years' cycle. The woods for protection on the high grounds are subject to especial treatment, as no clear fellings take place, and care is taken to leave standing groups of foliage trees equally distributed over the whole surface. The usual rules followed are: early felling of the trees in a cycle of eighty years, leaving occasional large shelter trees, and utilising the undergrowth for purposes of renewal. The administration of the Domain forests in the Duchy of Coburg is carried on on scientific principles, and consists of regular felling at stated periods over certain areas; pine timber trees are usually cut every ninety years, while oak, ash, beech, birch, &c., are not cut till after 120 years' growth.

The Report on the general administration of Prussian State Forests treats of their organisation, expenditure, and results, and points to the desirability of introducing others than indigenous trees into the forests. On the subject of education in forestry it is stated that the School of Forestry at Eberswalde completed in June 1880 the fiftieth year of its existence, and had at that period in all nearly 1600 pupils. There is also a School of Forestry at Münden, and the half-yearly attendance at both schools showed in 1878 an average of 148 pupils, whereas in 1880 the number had increased to 210. The attendance was therefore largely on the increase, and it was then proposed to give voluntary education in these matters to the "Jäger Bataillonen" of the army. This plan has, according to latest accounts, been attended with so much success that the education has become obligatory, and forms a regular portion of their service.

From Russia a very elaborate Report treats, amongst other things, of the various kinds of trees found in Russia, with notes on their distribution, and some interesting facts on the consumption of wood and the uses to which it is put, showing that house and ship building consume a very large proportion, and that the minor industries when put together form a not unimportant total. After showing the extensive destruction of forests that has been going on in different parts of Russia for some years past, the Report considers the question of plantations along railways, the object of which is to protect the track from snowdrifts, and a list of the best trees and shrubs for this purpose is given. On the subject of tree-planting on the steppes of South Russia, it is stated that Count Kisseleff, when travelling through several provinces in 1840, found, much to his surprise, amongst the German colonists not only good kitchen gardens but also flourishing plantations of forest trees. The colonists had been obliged on every plot of land to plant a certain number of trees. The first experiences, however, were so severe that many of the colonists preferred to return to Germany; those that remained were forced to plant their allotments with trees which, with infinite trouble, they succeeded in doing, and these plantations are now a great ornament to the steppes, and from a climatic as well as an agricultural point of view have been of great importance to the colonists, and have laid the foundation of the planting which is now carried out on the steppes in a scientific manner. A forestry school was established, but closed in 1866, and the allowances for planting which had been granted were reduced to a minimum. Since that, however, matters have been put on a more satisfactory footing, and planting is conducted in a systematic manner.

STONE HATCHETS IN CHINA

LITTLE has yet been done to illustrate the Stone Age in China, and this is very likely to be true for some time to come from the fact that the people of the country worked in metals four thousand years ago.

To begin with the Han dynasty, B.C. 206 to A.D. 220, one chief source of revenue was iron in those days, and Shansi had grown rich and powerful because of her iron foundries. The correct Confucianists objected to the spirit of gain-seeking which they saw showing itself in the expansion of trade. In the reign of Chauti, B.C. 80, a book was written on the salt and iron duties, which was a record of the views then maintained by the purists of the Confucian school in contrast with those of the political economists of that day. The advantages of the encouragement of trade were detailed in full, and the sympathy of the modern reader goes with the economists, who saw that the strength and prosperity of the country must be increased by developing her resources. The country was then old, and the stone hatchet period must be sought much earlier. The same state of things existed in the time of Kwan chung, B.C. 700. Living before Confucius, he could, as Minister of the Tsi kingdom, encourage trade without opposition from the literary class. His book speaks of the trade then existing between the different parts of China and the outside countries, and mentions gold as a product of the Ju and Han Rivers. Pearls come from the south ; jade comes from Tartary ; white ring plates come from the Kwun lun Mountain. Money was threefold. Pearls and jade were money of the first class. Gold was money of the second class. Knife money and cloth were money of the third class. This being the state of things at the beginning of the seventh century before Christ, the stone hatchet period must be sought farther back. It is said of the Emperor Cheng Tang, B.C. 1766, that he coined gold ; and of the Emperor Shun, B.C. 2255, that he hid gold in the earth to check the covetous spirit of the people. In the book of history is recorded the tribute which was offered to the Emperor from various parts of China in the time of Yü, B.C. 2205. All the common metals were included among the articles offered.

Recently a stone hatchet was found near Kalgan in a mound forty feet high. The mound belongs to a large collection of graves, large and small, about seven miles east of the city Yü cheu, and 110 miles west of Pekin. An ancient wall, nearly round, twenty feet high and about eight miles in circuit, is still in existence there. The mound in which the hatchet was found is in the line of this wall—that is, the wall runs north-west and south-east from it. Hence the wall-builders did not regard the mound as sacred, for it would not in that case have been made to serve the purpose of a wall to their city on the south-west side.

There is another large mound known as the grave of Taì wang. It is a little to the east of the centre of the inclosed space once a city, and the principal road runs through the city by this mound from east to west. Rev. Mark Williams of Kalgan, who found the hatchet, and was the first foreigner to draw attention to the old city, was struck with the general resemblance of the mounds, the wall, and the hatchet to what he is familiar with in Ohio. So close was the similarity that it seemed to him to require that the same class of persons who made the one should have made the other.

A Chinese archæological work of the seventeenth century, "Fang yü kì yau," mentions the city but not the mounds. The city, it says, was built in the reign of Han kau tsu, B.C. 206 to 194. Han kau tsu gave to his brother Hì the title and principality of Taì wang, and this was his residential city. The traces remain (it is added in this book) of nine gates. A river from the north enters the wall in the west, proceeds to the south-east, and from thence flows to the Tsz River. This prince was attacked by the Hìung Nu Tartars, and they must have taken the city, for he fled to his brother in Shensi, and was degraded to a lower title of nobility for cowardice shown on this occasion. Before this, in the interval between the fall of the Tsin dynasty and the establishment of the Han, there had been two other persons who had been styled Taì wang. Hìang yü, who took the capital of the Tsin dynasty and burnt its palaces, resolved to restore the feudal system and made several kings.

Chau hìe was one of these, but he removed shortly after to a different locality. After this there was another occupant of this principality, Chen yü. He was appointed by the ruler of Chau. But soon Lìeu pang subdued all China, and everything was changed. Besides these persons there is mentioned in the year B.C. 457 another Taì wang. The account which speaks of him is in the "Shìh kì," chapter xliii., where the author is relating the fortunes of the house of Chau. The elder sister of the Prince of Chau was the wife of Taì wang. While brother and sister were in mourning for their father, the former invited Taì wang, his brother-in-law, to a feast, and directed the cooks to attack and kill him with their copper ladles, which they had first used in presenting food to him. The widow afterwards committed suicide with her hair-pin. The object of the ruler of Chau in the murder was to obtain the dominions of the Taì wang for himself. The people of the locality, adds the historian, pitied the unhappy queen, and after her death named the mountain where this event took place "the hill of the suicide with a hair-pin," *mo kì chi shan*. When the Prince of Chau had effected the murder, another work adds, he sent a messenger to his sister to say, "To feel indifference for a husband's death because it was caused by a brother would not be kindness. To hate a brother for a husband's death would not be right." After hearing this speech she committed suicide, and the envoy at once followed her example and put an end to himself. The feelings of the people were much stirred by these events, and it seems likely that one of the large mounds would be raised to the assassinated Taì wang. This however is not certain, and the number, names, and dates of other persons who bore the title are now beyond the reach of investigation.

Several pieces of broken pottery were found by Mr. Williams in the neighbourhood of the mound, and their pattern is different from modern crockery ware. The small mounds are in groups chiefly outside the wall, and seem to be all placed irregularly. The hatchet is about five inches long, and is made of a black stone not heavy when held in the hand. It resembles in shape those preserved in Ohio museums.

On the whole, as the reader of this account will agree, the highest of the two large mounds is most likely the tomb of the prince assassinated, in the manner here described, in the year B.C. 457. The village in the centre. and the large mound second in size near it, popularly called Taì wang, probably indicate that a later personage was buried there.

I should add to this statement that there is in Kwan chung a passage in the twenty-fourth chapter which is as follows:—"Hwan kung, ruler of Tsi, asked Kwan chung, 'What produce is there in the Taì country?' The philosopher replied, 'White fox-skins. They are, however, dear to buy. They appear in the sixth month, when the yang principle changes to yìn. If you, the ruler of Tsi, offer to buy them at a high price, the people of the Taì kingdom will at once, from the hope of gain, go out in force to hunt for them. Tsi keeps its gold and waits. While the Taì people are hunting in the wilds and off their guard, their enemies on the north, the Lai ti, will attack them, and in this case the Taì country will fall to Tsi.' The ruler of Tsi adopted this plan for obtaining possession of Taì, and sent envoys with money to negotiate for white fox-skins. The King of Taì, hearing what they desired, said to his chief councillor, 'The money offered to us by Tsi is the very thing for want of which we are not equal to the Lai ti people. It is fortunate that this proposal is made to us.' He then ordered his people to go out hunting for white fox-skins. During twenty-four months they searched without finding any. The Lai ti people learned that the Taì kingdom was not in a state of defence, and attacked its northern frontier. The Taì wang in great fear gathered his troops and posted them above a defile called the valley of Taì. The invasion proceeded, and the Taì wang took his soldiers with him and submitted to Tsi. So in less than three years Taì submitted to Tsi without its being necessary to spend any money on the purchase of the skins which Kwan chung praised."

This passage must by fair criticism be ascribed not to Kwan chung himself but to some unknown author of the age of the contending States three or four centuries later. There was no Taì kingdom in the time of Kwan chung, and invention of this sort was common in the period of the contending States. Kwan chung had ascribed to him many expedients of statecraft which never occurred to him, and this of the fox-skins was amongst them.

JOSEPH EDKINS

NOTES

M. JANSSEN has been appointed by the Paris Academy of Sciences to represent the French Government in the Congress which is to be held at Washington to determine the choice of the first geographical meridian. It is just to state that the original idea of a universal first meridian belongs to France, and that as far back as 1632 a decree signed by Louis XIII. and proposed by Cardinal Richelieu established a universal meridian on the island of Ferro. This meridian was ultimately abandoned by Cassini to gratify Louis XIV.'s pride, and the Paris one was retained by the Metric Commission in 1793 under the pretence that an arc of this meridian had been measured for determining the length of the unit of measure.

WE regret to announce the dea'h of Dr. Heinrich Schellen, formerly director of the Cologne Realschule, and author of two well-known works, "Der electromagnetische Telegraph" and "Die Spektralanalyse." Besides these, Dr. Schellen published a book on arithmetic, an excellent German version of Padre Secchi's great work on the sun, and various other works on physical subjects. It was under his directorship and by his efforts that the Cologne School was raised from the rank of "Bürgerschule" to that of "Realschule erster Ordnung," and that it attained the high reputation it now enjoys. He died in Cologne in the first week of September, aged sixty-six years.

WE regret to announce the death of M. Jean Augustin Barral, the Perpetual Secretary of the French Société d'Agriculture, and the chief editor of *L'Agriculture*, a periodical of large circulation, and which, of all the Continental agricultural papers, was the most intensely devoted to the adaptation of English principles of rural economy to French conditions. M. Barral was born in Metz in 1820, and was a pupil of the Polytechnic School, where he was a *repetiteur* of chemistry for some time. He became most intimately connected with Bixio, the editor of *Maison Rustique*. Bixio and Barral made two daring aëronautical ascents from the Observatory grounds in 1850, when they ascended to an altitude of 18,000 feet, a height unsurpassed except by Glaisher and Tissandier. When Arago died he selected M. Barral, who had acted as his secretary for a long period, to publish his works. The Barral edition contains twelve large octavo volumes, exclusive of the "Astronomie Populaire," which fills four other volumes, and has been translated into almost every language. M. Barral edited the *Revue Horticole* and the *Journal d'Agriculture Pratique* for many years; it was on the occasion of the death of his friend Bixio that he resigned and started *L'Agriculture*, of which he was not only the editor but also the proprietor. He edited for ten years the *Revue de la Presse Scientifique*, an influential paper whose publication was stopped after a brilliant existence of eight years. M. Barral was a very popular character, much appreciated in Paris, where his loss will be heavily felt. Besides his editorial work he has written some popular works on scientific topics, and he leaves a number of academical essays, of which some have been edited under the form of pamphlets.

THE death is announced at Meran of Dr. Settari, one of the authorities on Lepidoptera.

A WARSAW correspondent informs us that on the 16th inst. there died in that city Jakób Natanson, formerly Professor of Chemistry in the principal school there. The late Prof. Natanson prepared carbamide synthetically by the action of ammonia gas on phosgene ($COCl_2$) in 1856. Prof. Natanson wrote many scientific papers in the Polish language; the most valuable are a text-book of chemistry ("Krótki mykład chemii organicznéj") and a treatise on organic chemistry. He also improved the methods of determining the density of vapours.

MESSRS. CASSELL AND CO. announce the forthcoming publication of "A History of British Fossil Reptiles," with 268 plates, by Sir Richard Owen, K.C.B. The edition, it is stated, consists of 170 copies only (each copy being signed by Prof. Owen), and no further number can be produced, as the plates from which the illustrations have been printed have been destroyed.

THE German Association of Naturalists and Physicians met last week at Magdeburg.

THE French Association for the Advancement of Science has decided that its next meeting will be held at Nancy. The President of this session, which promises to be most interesting, will be M. Friedel, member of the Academy of Sciences and Professor of Chemistry at the Sorbonne. The general secretary will be M. Collignon, Professor of Mechanics to the École des Ponts and author of the text-book on mechanics used in almost every French academy.

THE autumnal meeting of the Iron and Steel Institute was opened at Chester on Tuesday, when Dr. Percy, F.R.S., was elected President.

THE Social Science Congress has been meeting at Birmingham during the past week. In the Education Department Mr. Oscar Browning was President, and in his inaugural address he contrasted the ardent desire for a University education displayed by the Germans, who were content to beg to obtain it, with the apathy displayed in England. Our primary education was organised in a manner which became more effective every year. A complete system of University education which should lead the best scholars from the primary school to the University, and which should educate the bulk of the middle class, could not be said to exist. This was a crying want; it paralysed the activity of England in many directions, and the want could not be adequately supplied without the initiative of the State. On the Continent there might be too much theory and too little practice, but in England we had suffered until lately from having no theoretical training at all. He advocated such a technical education as that by which the Continent had progressed so much during the last half-century. Contrasting Germany and England he showed how a youth naturally fitted for an academic career could, however poor, by State aid go to the German University, while he had no such sure road in England. The best means by which this deficiency in our national life could be supplied, he thought, would be, first, by putting ourselves on an equality with other nations by determining that in every town in England of a certain size there should be at least one State school, where, for a very moderate charge, an education of the classical type should be given equal to the best which the country could supply, and that by the side of this, either in the same school or in a separate establishment, according to the population of the town, there should be facilities for passing a curriculum of modern education which should fit a man either for a commercial or for a scientific career. It could not be hoped that such schools would be self-supporting, and the time would come when the amount contributed by the Budget to national education would mark the national prosperity.—In a paper in the same Section, Dr. H. W. Crosskey said that in order that science may be effectively taught in public elementary schools, it must be taught experimentally. Actual demonstrations must accompany the lessons at every stage. It must be taught systematically and continuously. The "getting up" of some branch of science during three or four months as a "specific subject" is of little use. Special science demonstrators must be appointed. No man can be a good demonstrator who does not devote to the work the greater part of his daily life. The ordinary master of a school has many duties to discharge. He cannot by any possibility give any sufficient proportion of his time to the art and practice of scientific demonstration. By the peripatetic system experimental lessons can be given at every school, by a trained man of science, at a moderate cost. A central laboratory is erected in which experiments are prepared. The demonstrator visits each school in succession, the apparatus being brought by a hand-cart from the laboratory. The results actually attained in Birmingham were described. It was argued that experimental teaching gives the death-blow to cram, and that the elements of ordinary education are better mastered when the intellectual life of the scholars is aroused by science. The arrangements of the peripatetic system will suffice until the Sixth Standard is passed ; but special provision must be made for those lads who can remain a year or two longer at school, and whose future employments render the extension of their scientific training desirable. To meet the wants of this class, a school has been opened as an experiment in New Bridge Street, Birmingham, in premises belonging to the Chairman of the Board (Mr. George Dixon), who, at the cost of more than 2000*l.*, has adapted them for the purpose, and placed them rent free at the service of the Board. It is specially intended for scholars who will have to become working-men, but whose parents can keep them at school after they have passed the Sixth Standard, and the fee (3*d.* a week) is adapted to their means. There is a special master for chemistry and metallurgy, another master for mechanics and physics, a drawing-master, and a mathematical master, a highly-qualified scientific man being placed at the head. Workshop instruction is provided, and includes a knowledge of the chief wood tools, and the properties of materials, while it supplements the mechanical drawing of the schoolroom, and it is an aid to the study of theoretical mechanics. The course of instruction is arranged to extend over two years. It is not an attempt to benefit a few picked scholars, or to provide a higher-grade school for those able to pay high feees, but it is a continuation of the science training given by means of the peripatetic method in every ordinary elementary school under the Board.

THE Americans are not content with an Electrical Exhibition at Philadelphia ; we see that there is to be another at Boston this year, opening on November 24 and closing on January 5, 1885. Space and power to be found free, but there is an entrance fee of ten dollars. The object of the Exhibition is stated to be "to show the rapid advancement that has been made in electricity, its methods and appliances, and all its possibilities and probabilities."

WE are requested to announce that the Fifth Annual Cryptogamic Meeting of the Essex Field Club will be held on Friday and Saturday, October 3 and 4, in Epping Forest. The meeting will be under the direction of Dr. Cooke, Dr. H. J. Wharton, Mr. Worthington Smith, Rev. Canon Du Port, Rev. J. M. Crombie, Prof. Boulger, Mr. David Houston, Mr. F. J. Hanbury, Mr. Henry Groves, Mr. W. W. Reeves, Dr. Spurrell, and other well-known botanists. Those wishing to attend the meeting should apply for programmes and tickets to the Honorary Secretary, Buckhurst Hill, Essex.

WE stated some months ago that Capt. Scheele of the Swedish rading barque *Monarch*, before leaving Sweden for Melbourne, had asked the Zoological Museum at Upsala to lend him the necessary apparatus, vessels, &c., for deep-sea researches, with which request the Museum gladly complied. The results appear to have been so fruitful, that the *New York Herald* and the *Sun*, on the vessel recently arriving in New York, sent representatives on board, and devoted a great deal of space to descriptions of the collection made by "the intelligent Swedish seaman." The collection is, it is stated, very rich, filling two hundred vessels, and contains many new varieties. It will be forwarded to Upsala, while Capt. Scheele proceeds with his scientific researches during a voyage to the West Indies.

ONE of the most remarkable articles of export ever despatched for scientific purposes from any country is without doubt the consignment which has just left Norway for Germany. It is no less than fifty-two skeletons of Lapps, which have during the summer been unearthed at Utsjok in Russian Lapland, and which an enterprising dealer of Vardö has sold to various museums and societies on the Continent at the price of 6*l.* a piece. Two of the skeletons are those of children, the rest those of adults.

THE Berlin Academy of Sciences has commissioned Dr. Georg Volkens, a young botanist, to proceed to the sulphur-baths of Heluan, which are situated some 20 kilometres west of Cairo, in order to make a thorough investigation of the anatomy of desert plants, and microscopical researches concerning the growth of these plants.

UP to the present the North Cape on Mager Oe was considered to be the northernmost point of Europe. Capt. Sörensen, however, has recently found that Cape Knivskjaerodden, on the same island and west of the North Cape, lies 30″ to the north of the latter; 30″ of arc would correspond to about 926 metres. The latitudes found by Capt. Sörensen for the two capes are 71° 10′ 15″ N. for the North Cape, and 71° 10′ 45″ N. for Cape Knivskjaerodden.

A SEVERE earthquake occurred at Windsor, Ontario, at a quarter to three on the afternoon of September 19. Shocks were felt at twenty minutes past two at Grasslake, Michigan, where some school children fainted with alarm, and at Toledo, Ohio, and neighbouring towns. The shocks lasted fifteen seconds, and in some instances buildings rocked and their contents were displaced.

MM. D. TOMMASI AND RADIQUET have brought out a new battery with two carbon electrodes. The positive electrode consists of a carbon plate placed at the bottom of a porcelain vessel and covered with peroxide of lead, the negative electrode consists of a carbon plate containing on its upper surface platinised coke. The two plates are separated by a sheet of parchment paper. The liquid used is a saturated solution of common salt, which must not completely cover the upper plate. The E.M.F. on closed circuit is 0·6 volts.

IN a paper on "Electric Lighthouses" M. De Meritens gives some very interesting figures in comparing oil and electricity as illuminants. The figures, he states, are taken from two memoirs by M. Allard. As an example, the light at Dunkirk, obtained from mineral oil, is 6,250 candles, which in weather of mean transparency is seen for 53 km. ; if this be compared with an electric light of 125,000 candles, it is found that the electric light is seen for 75·4 km. Thus, an increase in the illuminating power of twenty times only increases the penetrative distance 22 km. or 42 per cent. If we now take a less transparent state, the ratio is reduced to an increase from 24 to 32 km. or 34 per cent. Or, lastly, in very foggy weather the distances are 3·7 and 4·6 km., showing an increase of 24 per cent. From these general figures M. Allard has calculated that in foggy weather in the Channel the luminous intensity with oil of 6250 carcels is 3·805 km. ; then, if this be increased to an oil illumination of 125,000 carcels, the luminous intensity of 4·740 km. Now, comparing this with an electric light of 125,000 carcels, he finds the luminous distance to be 4·696, or the penetrating power of the electric light is less than 1 per cent. less than mineral oil, whilst its cost, as computed by both English and French engineers, is from four to six times less than that of oil.

THERE is unfortunately now no doubt that Phylloxera has begun to appear in Rhenish Prussia. The districts of Heimersheim and Lohrsdorf in the valley of the Ahr are hopelessly infected and considered lost. Every effort is being made to prevent the pest from spreading.

THE Japanese appear to be determined to render themselves, as far as possible, independent of foreign countries. They have, says the *Pharmaceutical Journal*, established in Tokio a factory for the production of pharmaceutical chemicals on a large scale. A company with a capital of about 40,000*l*. has been formed for this purpose. Of this amount the Government has contributed one-half free of interest for twenty years, besides making a free grant of land and erecting the necessary buildings. A similar company is taking up the utilisation of the waste *saké* from the native breweries in the manufacture of alcohol, and the manufacture of bleaching-powder on a large scale has been commenced. Whether with the object of "protecting" the first of these enterprises or not does not appear, but we learn from the same authority that an increased tax has been placed in Japan on imported patent medicines, and the nature of the articles to which this has been extended is stated to have largely affected the import of some chemicals into that country. Santonin, which was at one time much in request among the Japanese, decreased 20,000 ounces in import last year, although the price was lower; on the other hand, the consumption of quinine showed an increase.

IN a paper read before the Vaudois Society of Natural Sciences, M. Schnetzler explained the results of his studies on the colour of flowers. He argues that only one colouring substance exists in plants, and that the various colours of flowers are only due to the modifications made in this substance by the acids or alkalis contained in the plants themselves.

A VICTORY has been gained by Van Rysselberghe in Belgium by the solution of the problem of transmitting a telegraphic and a telephonic message along the same wire at the same time. A trial of this has been made at the Antwerp Universal Exhibition, where concerts held in important towns in Belgium were heard; the transmission being made with ordinary instruments along ordinary telegraph lines and with earth returns.

M. COLLADON has observed a curious phenomenon connected with hailstones. He observed, on some occasions, that two or three seconds after they had fallen they sprung into the air again, to a height of 0·25 m. or 0·30 m., as if they had been struck upwards by the earth.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♂), a Ludio Monkey (*Cercopithecus ludio*) from West Africa, presented by Mr. A. Bowden; an Australian Fruit Bat (*Pteropus poliocephalus*) from Australia, presented by Capt. C. D. Long; a Tawny Owl (*Syrnium aluco*), British, presented by Miss H. Freeman; a Coypu Rat (*Myopotamus coypus*) from South America, presented by Mr. Frank Parish, F.Z.S.; two Black-billed Tree Ducks (*Dendrocygna arborea*) from Antigua, West Indies, presented by Mr. C. Arthur Shand; a Blackcap (*Sylvia atricapilla*), British, presented by Mr. H. Keilich; a Spanish Terrapin (*Clemmys leprosa*), South European, presented by Master A. Brierly; a Horned Lizard (*Phrynosoma cornutum*) from California, presented by Mr. Alfred R. Wallace, F.Z.S.; an Indian Python (*Python molurus*) from Ceylon, presented by Mr. A. A. Dalmege, F.R.G.S.; a Bonnet Monkey (*Macacus sinicus*) from India, two North African Jackals (*Canis anthus*) from Spain, deposited; two Half-collared Turtle Doves (*Turtur semitorquatus*), two Triangular-spotted Pigeons (*Columba guinea*), two Bronze-spotted Doves (*Chalcopelia chalcospilos*), four Harlequin Quails (*Coturnix histrionica*), an Allen's Porphyrio (*Hydrornia alleni*) from West Africa, received on approval; a Levaillant's Cynictis (*Cynictis penicillata*), three Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE FIGURE OF URANUS.—In a note communicated to the Reale Accademia dei Lincei, Prof. Millosevich collects the measures of Uranus which have been made by various observers, and adds the results of several series made by himself at the Observatory of the Collegio Romano. While the recent measures of Schiaparelli at Milan are in accordance with those of Mädler at Dorpat, as regards a very sensible ellipticity, most observers have failed to recognise, or at least have not referred to, any measurable quantity, amongst them Engelmann, Vogel, Lassell, Marth, and Kaiser. It is a point which might be expected to be readily settled if large telescopes were brought to bear upon it, and particularly if the double-image principle of measurement were employed.

THE LUNAR ECLIPSE ON OCTOBER 4.—During this eclipse the moon will be in a somewhat bare part of the sky, and with one exception no star brighter than the tenth magnitude will be occulted while she is immersed in the earth's dark shadow, or between 9h. 16m. and 10h. 48m. One of the tenth magnitude, of which an accurate position is given in vol. vi. of the Bonn Observations disappears at 9h. 33m. 35s. and reappears at 10h. 37m. 54s., the angles being respectively 137° and 271°; No. 800 of Weisse's Bessel, 0h. R.A., disappears at 10h. 35m. 24s. at 100°, but does not reappear till 11h. 45m. 35s. (308°) when the moon will have begun to emerge from the shadow; this star is estimated 9 m. by Bessel. The times are for Greenwich.

OLBERS' COMET OF 1815.—In Nos. 2613–14 of the *Astronomische Nachrichten* Prof. Krueger has printed the sweeping-ephemerides for this comet calculated by Herr Ginzel of Vienna, at least between the dates October 1 and January 1. Although the epoch of perihelion passage directly resulting from the computation of the perturbations during the present revolution does not fall before December 1886, the discussion of the observations in 1815 left an uncertainty of ± 1·6 year in the time of revolution at the instant of perihelion passage in that year, and it may be well to commence a search for the comet forthwith; it is to be remarked, however, that, should it reach perihelion in midwinter in these latitudes, it is not likely to pass unobserved, the intensity of light being then at a maximum, and the comet at a high north declination.

THE COMET OF 1729.—"La Comète de 1729 est de toutes les comètes, observées jusqu'en 1780, celle qui a été vue à la plus grande distance du Soleil et de la Terre," writes Pingré in his "Cométographie." Upwards of a century has since elapsed, and yet no comet observed in the meantime has had a perihelion distance at all approaching that of the comet discovered by Père Sarabat at Nismes on July 31, 1729. The comet was seen until the end of January following, and was observed by Cassini until the 18th of that month. From some of his observations newly reduced, Burckhardt calculated both parabolic and hyperbolic orbits which were first published in the *Connaissance des Temps* for 1821. Recently, employing Burckhardt's reductions of Cassini's observations on September 3, November 10, and January 16, Mr. Hind has found the following parabolic elements:—

Perihelion passage, 1729, June 16·15422 M.T. at Paris

	°	′	″	
Longitude of perihelion	321	2	46·1	Mean
,, ascending node ...	310	37	8·3	Equinox
Inclination	77	4	6·0	1730·0
Logarithm of perihelion distance..	0·607513			

Motion—direct

By which the middle observation is represented within 16″ in longitude and 10″ in latitude. The distances from the earth and sun at the times of the three observations are:—

1729 Sept. 3 ...	From Sun, 4·107 ...	From Earth, 3·142
Nov. 10 ...	,, 4·240 ...	,, 4·339
1730 Jan. 16 ...	,, 4·439 ...	,, 5·132

The distance in perihelion is 4·05, the earth's mean distance from the sun being taken as unity. The comet of 1747 had a perihelion distance of 2·198, which is the nearest approach to that of the comet of 1729; it was a very exceptional and extraordinary body.

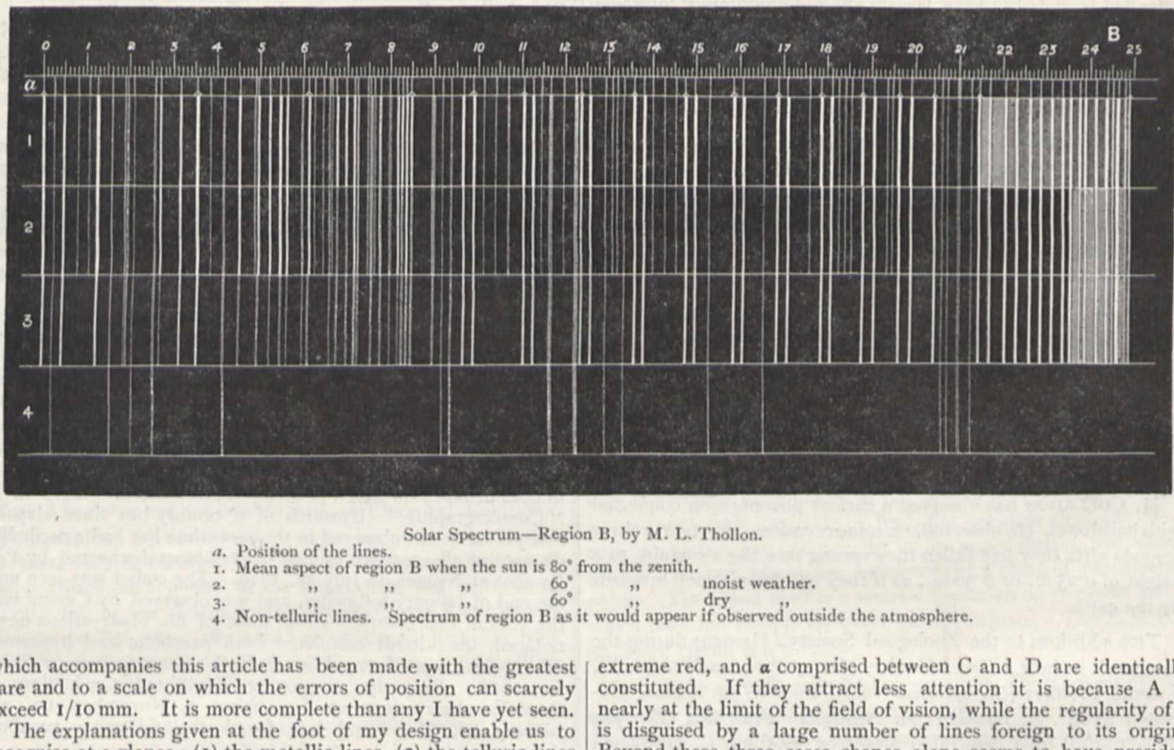
CONSTITUTION AND ORIGIN OF THE GROUP B OF THE SOLAR SPECTRUM[1]

WHEN a single prism spectroscope is directed towards the sun at the moment when it is in the neighbourhood of the zenith, we perceive near C, at about a fourth of the distance separating it from the extreme red, a strong black line, which Frauenhofer has named B. Under a more powerful instrument of five or six prisms this line becomes a very black broad band, separated from the region of C by what may be described as almost an empty space, the lines which do exist in it being few and faint. On the other side this band is followed by well-marked lines, which appear to be very regularly spaced, and the first of which show some indications of being double. Father Secchi had vainly attempted to resolve the band B; on this subject he writes:—

"Certain bands which in ordinary instruments seem to be stumped consist in reality of numerous perfectly distinct lines, as is seen in a spectroscope possessing great dispersive power; but some of them are really massed towards the edge, and there it is impossible to separate them, however powerful the instrument employed. We may cite as an example the lines of the group B" (*Le Soleil*, vol. i. ed. 1875, p. 235).

The statement of the learned physicist shows that, at the time he wrote the above, spectroscopic apparatus had not been brought to very great perfection or power. In point of fact the dispersion of eight or ten prisms suffices to show that the band B is really formed of a large number of distinct lines. With my highly-dispersive instrument it becomes resolved in a truly marvellous manner. The seventeen lines composing it are distinguished with the greatest clearness, and may be very exactly measured. Those following it on the red side are all broadly doubled, presenting in their regularity a very remarkable appearance.

In 1878 Messrs. Piazzi-Smyth and Langley succeeded for the first time and almost simultaneously in resolving this group. Piazzi-Smyth, working with prisms, obtained only an incomplete resolution, whereas, by means of Rutherford's excellent appliances Langley not only separated all the lines, but also determined their wave-lengths. Being unaware of the work of these physicists, I fancied I had been the first to obtain these results in 1879, when making the first essays with my highly-dispersive apparatus. The sulphide of carbon compound prisms, which M. Laurent had just made, were merely mounted on a drawing-board, were badly regulated, badly sheltered from variations of temperature, and could not yield the results that I now obtain. The drawing which on that occasion I published in the *Comptes Rendus* is incomplete and inaccurate. That



Solar Spectrum—Region B, by M. L. Thollon.

a. Position of the lines.
1. Mean aspect of region B when the sun is 80° from the zenith.
2. " " " 60° " moist weather.
3. " " " 60° " dry "
4. Non-telluric lines. Spectrum of region B as it would appear if observed outside the atmosphere.

which accompanies this article has been made with the greatest care and to a scale on which the errors of position can scarcely exceed 1/10 mm. It is more complete than any I have yet seen.

The explanations given at the foot of my design enable us to recognise at a glance: (1) the metallic lines, (2) the telluric lines produced by the variable element of the atmosphere (beyond all doubt aqueous vapour); (3) the telluric lines proceeding from the constant elements (oxygen, nitrogen, carbonic acid). The group is thus seen to consist of a pencil of seventeen rays, constituting properly speaking Frauenhofer's B-band; of a system of twelve couples with intervals increasing regularly from right to left, whereas the distance of the constituents diminishes with equal regularity in the opposite direction; lastly, of a somewhat important group belonging to the vapour of water, the whole interspersed with a few weak metallic lines.

When we survey the solar spectrum given by my apparatus, beginning with the violet, and when we behold the thousands of lines composing it distributed in all the regions without any apparent kind of order, on arriving at the group B we feel, as Mr. Langley remarks, the same impression as does a traveller lost in a virgin forest when he suddenly finds himself in the presence of a perfectly straight avenue of trees planted with mathematical regularity. It should be added that A at the extreme red, and α comprised between C and D are identically constituted. If they attract less attention it is because A is nearly at the limit of the field of vision, while the regularity of α is disguised by a large number of lines foreign to its origin. Beyond these three cases chance alone seems to have presided over the distribution of lines throughout the whole spectrum.

But the interest attaching to these groups is due not only to their remarkable appearance, but also and especially to the question of their origin. In what regions are produced the absorptions which give them birth? In the solar atmosphere, in the terrestrial atmosphere, or in some medium comprised between the sun and the earth? Do these absorptions proceed from a common element, and if so what is its nature? The most contradictory answers have been given to these various questions, which have already long since been asked.

To speak only of B, after his memorable experience of La Villette in 1866, M. Janssen asserted that this group was at least to a great extent due to aqueous vapour. The little sketch published by him in the *Annales de Chimie et de Physique* (4th series, vol. xxiv. p. 217) in fact shows, facing B, bands of absorption due to the vapour of water, and corresponding exactly to the spectral bands yielded by the setting sun in this region. On the other hand, Ångström, who had devoted much study to the question, tells us that at the low temperature of 27° C.,

[1] Paper by M. L. Thollon in *Bulletin Astronomique*, May 1884.

when the other telluric lines had almost entirely disappeared, he saw B perfectly distinct. At a like zenith distance from the sun this group seemed to him even blacker and more intense than usual. Hence his inference that it could not proceed from the vapour of water. This eminent physicist, a thoroughly convinced partisan of spectral unity for the simple gases, had ascertained that in the spectrum of atmospheric emission there was no trace of any ray or band corresponding to B. It followed for him that the air could not absorb radiations it was incapable of emitting. If therefore this group, variable like the other telluric rays, could be attributed neither to aqueous vapour, to nitrogen, nor to the oxygen of the air, from what element did it derive its origin? Ångström spoke of carbonic acid, but perhaps without believing in it. He seemed deeply interested in Tyndall's experiments on the absorbing power of gases by heat. We know that this skilful investigator had found that the coefficients of absorption of oxygen and nitrogen by no means corresponded with the coefficient of absorption of the air. The difference he attributed to some unknown element sufficiently rarefied to escape our analyses, and endowed with immense absorbing power. Ångström had probably this unknown element in his mind, but he remained uncertain to the last.

The great authority of the Swedish physicist could not fail to have its influence on the judgment of those approaching the question after him. Captain Abney, who has so greatly distinguished himself by his remarkable scientific labours, asserts in NATURE (October 12, 1882, p. 585) that the groups A and B cannot be regarded as telluric, but as proceeding from a medium lying between the sun and the earth. Piazzi Smyth, who had at first looked on B as telluric, seems to have finally adopted Captain Abney's views, and is disposed to think that B as well as A may after all be the product of some interplanetary medium. In his opinion the recent theories of Siemens seem to confirm his view of the case.

The attention that I have for several years paid to the portion of the solar spectrum stretching from A to *b* has naturally led me to deal with this subject. Here is the method by which I succeeded in separating and classifying the spectral lines. After certain preliminary measures taken with the greatest care to determine their exact position, each region of the spectrum is drawn on two maps. The first is intended to reproduce the appearance of this region when the sun is at 60° from the zenith, the second when at 80°. These distances have been chosen in such a way that in the latitude of Nice the observations may be continued throughout the year. When the weather seems favourable at the hour when the sun is in the desired position, the intensity of each line is marked on the map itself with all possible exactness, the hygrometric state of the air being indicated each time. The process is slow, delicate, and laborious, but the result is certain. After I have thus made eight or ten series of observations on each drawing, they are carefully examined, and the indications relative to any given line enable me confidently to decide:—(1) whether it is not metallic; (2) whether a telluric line belongs to a constant or to a variable atmospheric element. By this method I have been able to satisfy myself that A, B, and α are telluric groups due to the constant elements of the air. *At the same distance from the zenith they have always the same intensity.* I refer of course only to the main groups in each of them, and to the couples following them on the least refrangible side.

It remained to determine exactly to what atmospheric element the groups in question were to be attributed. M. Egoroff, Professor of Physics at the University of Warsaw, has recently succeeded in solving the problem. He had for several years ardently devoted himself to this inquiry, and in 1882 we jointly made a series of experiments on the subject in the Paris Observatory. A pencil of electric light directed from Mount Valérien on the Observatory, distant 10 km., gave us the spectrum of the telluric rays all but complete. There was no difficulty in distinguishing A, B, and α, which are so easily recognised. Capt. Abney has questioned the results obtained by us. Yet they are incontestable, and in any case the experiment can be easily repeated.

At last, after these preliminary studies, M. Egoroff, operating directly on oxygen closely compressed in a metallic tube, and traversed lengthwise by a pencil of strong light, has obtained the groups A and B. The thickness of the oxygen thus traversed was doubtless insufficient for the production of α. But however this be, it may now be confidently asserted that these three, which are of such remarkable appearance, and which so closely resemble each other, have their origin in the absorption due specially to atmospheric oxygen.

I need not dwell upon the importance of this result; but how is it to be reconciled with the observations of Messrs. Janssen, Ångström and Piazzi Smyth? To judge from the sketch contained in the *Annales*, and above referred to, M. Janssen must have seen in the spectrum of aqueous vapour bands corresponding to those of the solar spectrum in the region of B. One of them even coincides exactly with the chief member of the group. According to my own observations, to produce this effect the vapour of water would have to yield at this point a non-resolvable band, which would simply obscure the intervals between the lines, as is seen in the spectrum 1 of my drawing. This observation should then vary according to the hygrometric state of the air, and not, as it has always seemed to me, according to the height of the sun. Or else this band is not represented in the exact position it ought to occupy, and should be shifted more to the left, where in fact are found many lines of the vapour of water constituting an important group (see plate).

If, on the other hand, Ångström saw B more intense at a temperature of 27° C., it was doubtless owing to a simple effect of contrast. The other telluric lines being greatly weakened, those that retain their intensity must naturally appear blacker. Such an effect is frequently produced in the course of my observations, and against it I have to be constantly on my guard. And now how can we explain why the spectrum of absorption of the oxygen differs so much from its spectrum of emission? The lack of sufficient data renders all explanation impossible; but the certainty of the fact obliges us to conclude that *cold* has not the same properties as *incandescent* oxygen, and allows us to suspect that it may be the same with all gases.

In asserting that A and even B do not really vary in intensity when the sun approaches the horizon, such an eminent observer as Piazzi Smyth would have greatly surprised professional spectroscopists, were they not aware how difficult and delicate a matter is the management of an apparatus of highly dispersive power. Let but the luminous pencil be badly adjusted, the prisms less than faultlessly regulated, the slightest cloudiness settle on the surfaces, the images, especially in the extreme red, will at once appear as if drowned in the diffused light, which obscures the most evident effects and even disfigures their essential characters. Strange phenomena are often produced, the causes of which it seems impossible to discover, and which easily give rise to illusions. But when we work under favourable conditions with a well-designed and well-constructed apparatus, it becomes superabundantly evident that A and B vary considerably in intensity according to the height of the sun, and are certainly telluric.

During the total eclipse of 1882, both M. Trépied and myself fancied we observed on the edge of the lunar disk a notable strengthening of the rays of the B group. If Captain Abney's theory could have been confirmed, it would have certainly added great weight to our observations, and for my own part I should have felt highly satisfied at the result. Unfortunately, the atmosphere of oxygen which should now be attributed to the moon in order to produce the observed effects, seems scarcely reconcilable with the absence of refraction in the luminous rays striking the edge of our satellite. I greatly fear the results obtained in Egypt are one of those illusions, of which nearly all spectroscopists have been more or less the victims.

It would now be important to ascertain whether the nitrogen and carbonic acid of the air may not be represented by any line or any group in the solar spectrum. The study I am at present engaged in, according to the above described method, will not fail, I trust, to yield precise results on this important point. Hitherto, apart from the oxygen groups, I have discovered no line that may be confidently attributed to the constant elements of the atmosphere. Hence it is desirable to await the result of my researches before giving effect to the project adopted by M. Bischoffsheim to establish on Mont Gross metallic tubes of considerable length, in which the spectra of absorption of gases may be studied on a grand scale.

THE MIGRATIONS OF "SALMO SALAR" (L.) IN THE BALTIC

THE following statement gives further details supplementary to our recent article on this subject:—

Since the earliest times salmon have been caught in the Finnish rivers which had in their mouths or entrails hooks of a peculiar shape entirely unknown in Finland. Such hooks have been found in salmon taken in all Swedish and Finnish rivers falling into the Gulf of Bothnia. At one of the salmon fisheries in the Uleå River, for instance, where the fish is sold cleaned, twenty-five such hooks, all of brass, were collected last summer and handed to me. With a few exceptions the hooks are of one kind, viz. made of brass wire 2 to 2·5 mm. thick, a little compressed in the hook itself, while the length varies from 9·5 to 11·5 cm. Most of the hooks are 10·5 cm. in length, and the width of the bend 2·5 to 3·5 cm. Generally a bit of line 1 to 2 mm. thick, made of flax, hangs to the hook, while, when the line is long enough, a lead, conical in shape and 10 to 20 grm. in weight, is found on the same. Sometimes Latin characters are engraved on the lead, as, for instance, in one taken in the above-mentioned river last summer, which had on it "C" and "K" on each side. I am of opinion that all the hooks which have passed through my hands are of the same type and manufacture.

As it is of great practical value to discover whence these peculiar brass hooks have come, I have given considerable attention to the question, the result of which is that I have come to the conclusion that they were brought from the north coast of Germany, where they are used for salmon-fishing in the winter. Great fisheries are carried on along this coast in a depth of 30 to 60 m. and 10 to 30 km. from the shore, as far as, and probably beyond, the Russian frontier. The lines used are very like those used on the south coast of Sweden, but the hooks and leads are quite different. Prof. Benecke, of Königsberg, to whom I sent a hook taken from a salmon in the Uleå River, asserts too that these have come from the shores of Prussia and Pomerania. As hooks of this kind are not used in any other part of the Baltic or outside of it, it is evident that the salmon must have brought these from the above-mentioned places to the shores of the Gulf of Bothnia.

It is, on the other hand, but seldom that hooks of iron and tin are found in salmon in our rivers, which is caused, I believe, by the circumstance that the Scandinavians use far stronger lines for salmon-fishing than the Germans. I have, however, two in my possession which are of the exact kind used by fishermen in the sea about Bornholm and the south-east coast of Sweden.

Besides the above-mentioned kinds of hooks I have obtained a very peculiar one taken from a salmon off the town of Kristinestad. It is 4 cm. long, of hammered thick brass wire, and of a very uncommon shape, and through two holes fastened to two double-twined brass wires 40 cm. long, and 1 mm. thick. I do not know from what part of the Baltic this strange hook hails, but I believe from the Russian shore of the same.

The discovery of hooks of a foreign shape in salmon in the northern rivers of Sweden and Finland was made about 200 years ago, as may be seen in the journals of the Swedish Academy of Sciences of the seventeenth century, and even at that date their remarkable shape and manufacture attracted attention.

The relatively great number of brass hooks found in salmon taken in the rivers around the Gulf of Bothnia demonstrates beyond doubt that the fish, after visiting the coast of Northern Germany, return to the northernmost shores of Sweden and Finland, while some have visited the southern part of Sweden on their way north, as the iron hooks clearly indicate. If it is true, as is generally believed, that the salmon returns for spawning to the rivers of its birth, we may with equal force assume that the great takes of young salmon on the southern coast of Sweden and the shores of Baltic Germany during recent years is due to the rigid closing in of the rivers of Northern Sweden and Finland, whence they migrate south. During the last fifteen years, since when closing began in the Finnish rivers, the takes of young salmon—from 1 lb. to 2 lb. in weight—in nets about Bornholm and on the shores of Germany, have fabulously increased, and my opinion is that these fisheries are of such a destructive nature to this noble fish in Sweden and Finland that some arrangement ought to be made between the Baltic Powers to put a stop to the same.

By marking the salmon in England and Scotland, pisciculturists have come to the conclusion that varieties of salmon during their stay in salt water visit preferably certain parts of the coast for their food; thus, according to the late Frank Buckland, the shores around Yarmouth are the favourite haunts of the "bull-trout" of certain English and Scottish rivers. The great student of the salmon fisheries of Scotland, particularly those of the River Tweed, David Milne Holme, relates as an example of how quickly fish of the salmon kind can travel to a favourite feeding-ground, that a "bull-trout" marked with a silver thread with an inscription in the River Tweed, on March 29, 1852, was taken, on April 2, near Yarmouth, having thus accomplished a distance of nearly 300 miles in four days. Another fish was marked in the same river on March 10, 1880, and was caught at Yarmouth on May 5, having taken fifty-five days for the journey.

As the salmon, *Salmo salar*, according to the experience gained in Scotland, prefers sandy feeding-grounds during its stay in salt water, and as the bottom of the Baltic on the coast between Memel and Rügen, at Bornholm and South-East Sweden, is sand at a certain depth, where its favourite food is found, the cause of the migrations of the salmon in the Baltic southwards may be accounted for, while their return to the northern rivers of Sweden and Finland in the spring is unquestionably due to their breeding-instincts.

Helsingfors AND. JOH. MALMGREN

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee, consisting of Major-Gen. Sir A. Clarke, R.E., C.B., Sir J. N. Douglass, Capt. Sir F. J. O. Evans, R.N., K.C.B., F.R.S., Capt. J. Parsons, R.N., Prof J. Prestwich, F.R.S., Capt. W. J. L. Wharton, R.N., Messrs. E. Easton, R. B. Grantham, J. B. Redman, J. S. Valentine, L. F. Vernon-Harcourt, W. Whitaker, and J. W. Woodall, with C. E. De Rance and W. Topley as Secretaries, appointed for the Purpose of Inquiring into the Rate of Erosion of the Sea-coasts of England and Wales, and the Influence of the Artificial Abstraction of Shingle or other Material on that Action. Drawn up by C. E. De Rance and W. Topley.—The importance of the subject referred to this Committee for investigation is universally admitted, and the urgent need for inquiry is apparent to all who have any acquaintance with the changes which are in progress around our coasts. The subject is a large one, and can only be successfully attacked by many observers, working with a common purpose and upon some uniform plan. The Committee has been enlarged by the addition of some members who, by official position or special studies, are well able to assist in the work. In order fully to appreciate the influence, direct or indirect, of human agency in modifying the coast-line, it is necessary to be well acquainted with the natural conditions which prevail in the places referred to. The main features as regards most of the east and south-east coasts of England are well known; but even here there are probably local peculiarities not recorded in published works. Of the west coasts much less is known. It has therefore been thought desirable to ask for information upon many elementary points which, at first sight, do not appear necessary for the inquiry with which this Committee is intrusted. A shingle-beach is the natural protection of a coast; the erosion of a sea-cliff which has a bank of shingle in front of it is a very slow process. But if the shingle be removed the erosion goes on rapidly. This removal may take place in various ways. Changes in the natural distribution of the shingle may take place, the reasons for which are not always at present understood; upon this point we hope to obtain much information. More often, however, the movement is directly due to artificial causes. As a rule, the shingle travels along the shore in definite directions. If by any means the shingle is arrested at any one spot, the coast-line beyond that is left more or less bare of shingle. In the majority of cases such arresting of shingle is caused by building out "groynes," or by the construction of piers and harbour-mouths which act as large groynes. Ordinary groynes are built for the purpose of stopping the travelling of the shingle at certain places, with the object of preventing the loss of land by coast-erosion at those places. They are often built with a reckless disregard of the consequences which must necessarily follow to the coast thus robbed of its natural supply of shingle. Sometimes, however, the groynes fail in the purpose for which they are intended—by collecting an insufficient amount of shingle, by collecting it in the wrong places, or from other causes. These, again, are points upon which much valuable information may be obtained. Sometimes the decrease of shingle is due to a quantity being taken away from the beach for ballast, building, road-making, or other purposes. Solid rocks, or numerous large boulders, occurring between tide-marks, are also important protectors of the coast-line. In some cases these have been removed, and the waves have thus obtained a greater power over the land. To investigate these various points is the main object of the Committee. A large amount of information is already in hand, much of which has been supplied by Mr. J. B. Redman, who for many years has devoted special attention to this subject. Mr. R. B. Grantham has also made important contributions respecting parts of the south-eastern coasts. But this information necessarily consists largely of local details, and it has been thought better to defer the publication of this for another year. Meanwhile the information referring to special districts will be made more complete, and general deductions may be more safely made. As far as possible the information obtained will be recorded upon the six-inch maps of the Ordnance Survey. These give with great accuracy the condition of the coast, and the position of every groyne, at the time when the survey was made.

Appended is a copy of the questions circulated. The Committee will be glad of assistance, from those whose local knowledge enables them to answer the questions, respecting any part of the coast-line of England and Wales. Copies of the forms for answering the questions can be had on application to the Secretaries.

Appendix—Copy of Questions.—1. What part of the English or Welsh coast do you know well? 2. What is the nature of that coast? (*a*) if cliffy, of what are the cliffs composed? (*b*) what are the heights of the cliff above H.W.M.? Greatest, average, least. 3. What is the direction of the coast-line? 4. What is the prevailing wind? 5. What wind is the most important—(*a*) in raising high waves? (*b*) in piling up shingle? (*c*) in the travelling of shingle? 6. What is the set of the tidal currents? 7. What is the range of tide? Vertical in feet, width in yards between high and low water, at spring tide, and at neap tide. 8. Does the area covered by the tide consist of bare rock, shingle, sand, or mud? (*a*) its mean and greatest breadth; (*b*) its distribution with respect to tide-mark; (*c*) the direction in which it travels; (*d*) the greatest size of the pebbles; (*e*) whether the shingle forms one continuous slope, or whether there is a "spring full" and "neap full," if the latter, state their heights above the respective tide-marks. 10. Is the shingle accumulating or diminishing, and at what rate? 11. If diminishing, is this due partly or entirely to artificial abstraction (*see* No. 13)? 12. If groynes are employed to arrest the travel of the shingle, state—(*a*) their direction with respect to the shore-line at that point; (*b*) their length; (*c*) their distance apart; (*d*) their height—(1) when built, (2) to leeward above the shingle, (3) to windward above the shingle; (*e*) the material of which they are built; (*f*) the influence which they exert. 13. If shingle, sand, or rock is being artificially removed, state—(*a*) from what part of the foreshore (with respect to the tidal range) the material is mainly taken; (*b*) for what purpose; (*c*) by whom—private individuals, local authorities, public companies; (*d*) whether half-tide reefs had, before such removal, acted as natural breakwaters. 14. Is the coast being worn back by the sea? If so, state—(*a*) at what special points or districts; (*b*) the nature and height of the cliffs at those places; (*c*) at what rate the erosion now takes place; (*d*) what data there may be for determining the rate from early maps or other documents; (*e*) is such loss confined to areas bare of shingle? 15. Is the bareness of shingle at any of these places due to artificial causes? (*a*) by abstraction of shingle; (*b*) by the erection of groynes, and the arresting of shingle elsewhere. 16. Apart from the increase of land by increase of shingle, is any land being gained from the sea? If so, state—(*a*) from what cause, as embanking salt-marsh or tidal foreshore; (*b*) the area so regained, and from what date. 17. Are there "dunes" of blown sand in your district? If so, state—(*a*) the name by which they are locally known; (*b*) their mean and greatest height; (*c*) their relation to river mouths and to areas of shingle; (*d*) if they are now increasing; (*e*) if they blow over the land, or are prevented from doing so by "bent grass" or other vegetation, or by water channels. 18. Mention any reports, papers, maps, or newspaper articles that have appeared upon this question bearing upon your district (copies will be thankfully received by the Secretaries). 19. Remarks bearing on the subject that may not seem covered by the foregoing questions. [N.B.—Answers to the foregoing questions will in most cases be rendered more precise and valuable by sketches illustrating the points referred to.]

SECTION A—Mathematical and Physical Science

On Loss of Heat by Radiation and Convection as affected by the Dimensions of the Cooling Body; and on Cooling in Vacuum, by J. T. Bottomley.—In the course of a series of experiments on the heating of conductors by the electric current, which were carried on during the past winter, I obtained a considerable number of results which both gave me the means of calculating the *emissivity* for heat in absolute measure of various surfaces under different circumstances, and also caused me to undertake a number of special experiments on the subject. These experiments are still in progress, and I am making preparation for a more extended and complete series; but a brief notice of some of the results already arrived at may not be without interest to the British Association.

The experiments were made on wires of various sizes, some of them covered and some of them bare, cooling in air at ordinary temperatures, and at normal and also at very much reduced pressures.

The mode of experimenting was as follows;—

A current passing through a wire generates heat, the amount of which is given by Joule's well-known law—

$$H = C^2 R/J \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where C is the current, R the electrical resistance, J Joule's equivalent, and H the quantity of heat generated per unit of time; each being reckoned in C.G.S. units. Let l be the length of the wire, d its diameter, and σ_t the specific resistance of the material at temperature $t°$ (at which temperature let us suppose that the wire in the given external conditions is maintained by the current). Then

$$R = \frac{\sigma_t l}{\frac{1}{4}\pi d^2} = \frac{4\sigma_t l}{\pi d^2}$$

Hence from (1)—

$$H = \frac{C^2}{J} \cdot \frac{4\sigma_t l}{\pi d^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Consider, now, that the wire suspended in the air is losing heat by its surface, and let us suppose that it neither loses nor gains heat by its ends. Let H' be the quantity lost by emission from the surface per unit of time. Let e be the emissivity, or quantity of heat lost per unit time per unit area of the cooling surface per unit difference of temperatures between the cooling surface and the surroundings; and $t°$ being, as has been said above, the temperature of the wire, let θ be the temperature of the surroundings. Then

$$H' = \pi d l \,.\, e \,.\, (t - \theta) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

But when the wire has acquired a permanent temperature, with the current flowing through it, there is as much heat being lost at the sides as is being generated by the current. In this case $H = H'$; and we obtain the expression for e—

$$e = \frac{4\,C^2 \sigma_t}{J \pi^2 d^3 (t - \theta)} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

My experiments consist in measuring the strength of the current and the temperature of the wire, the latter being effected by measuring the electric resistance of a known length of the wire while the current is flowing through it, and hence inferring the temperature. These being known, and likewise the temperature of the surroundings, we have all the data for finding e, the emissivity of the surface in absolute measure. The experiments of Mr. D. Macfarlane giving emissivities in absolute measure are well known, and are of undoubted accuracy. They were communicated to the Royal Society (*Proc.* Roy. Soc., 1872, p. 93); and the results are quoted in Prof. Everett's "Units and Physical Constants" (chap. ix. § 137). These experiments were made with a copper globe about 4 cm. in diameter, suspended in a cylindrical chamber, with top and bottom, about 60 cm. in diameter, and 60 cm. high. The results may be briefly summed up as follows:—

Macfarlane finds an emissivity of about 1/4000th of the thermal unit C.G.S. per square centimetre per second per degree of difference of temperatures between cooling body and surroundings for a polished surface, with an excess of temperature of a little more than 60° C.; and, for a blackened surface, the same emissivity with an excess of 5° C. or under.

Using round wires of small diameter (0·85 mm. and under), and with the surfaces either brightly polished or in common dull condition of a wire fresh from the maker, I have found a much larger emissivity than 1/4000. I have obtained different values of e for wires of different sizes, varying from 1/2000 down to 1/400, which was obtained with a wire of 0·40 mm. diameter, and with an excess of temperature of 24° C. It seems to be shown by all the experiments I have made that, other things being the same, the smaller the wire the greater the emissivity.

To do away with the part of the emissivity which is due to convection and conduction by the air, I have commenced experiments on loss of heat by small wires in the nearly perfect vacuum afforded by the modern mercurial air-pump. This part of the subject was experimented on long ago by Dulong and Petit, and within the last few years by Winkelman and Kundt and Warburg; lastly, and much more perfectly, by Mr. Crookes (*Proc.* Roy. Soc., vol. xxxi. p. 239), though in no case, I believe, were the emissivities in absolute measure determined. The conclusion come to by all these experimenters is the same, namely, that there is a decrease of emissivity due to lowering of the air-pressure, this decrease being very small for a reduction down to one-half or one-third of the ordinary atmospheric pressure, but becoming very great as the vacuum approaches completeness.

The very interesting experiments of Mr. Crookes seem to show that, even with the high vacuum which he obtained, the effect of the residual gas in carrying off heat from the cooling body was far from being annulled.

The following table shows the emissivity of a copper wire with bright surface half a metre long, 0·40 mm. in diameter, and sealed into a glass tube about 1·5 cm. in internal diameter:—

Current in amperes	Pressure, 760 millims.		Pressure, 380 millims.		Pressure, 180 millims.		Very high vacuum pump worked continuously	
	$t-\theta$	e	$t-\theta$	e	$t-\theta$	e	$t-\theta$	e
1	4°·7	1/1822	4°·5	1/1784	5°·5	1/2176	17°	1/6443
2	22·5	1/2084	21·5	1/1996	23.5	1/2174	68	1/5620
3	56	1/2114	58	1/2180	55	1/2082	140?	1/4606 [1]

The following table may also be found interesting. It shows the emissivity in absolute measure of some materials commonly used as insulating coverings for wires.

Specifying number B.W.G. and nature of covering	Length of wire. Centims.	Resistance of 100 centims. B.A. units	Diameter of wire in millims.	Diameter of covered wire, outside measurement	Current (amperes)	$t-\theta$	Emissivity
No. 22, silk-covered ...	100	·0395	·76	·96	10	23°·4	0·001333
No. 26, cotton-covered	100	·094	·50	·88	10	58	0·001385
No. 26, silk-covered ...	100	·1115	·45	·57	9·8	70	0·002020
No. 22, gutta-percha...	100	·0455	·72	1·67	10	24	0·000854
No. 22, tinned, gutta-percha-covered, and double cotton covered outside	100	·0432	·73	1·86	10	23	0·000759

On Some Phenomena Connected with Iron and other Metals in the Solid and Molten States, with Notes of Experiments, by W. J. Millar, C.E., Sec. Inst. Engineers and Shipbuilders in Scotland.—1. *Object of Paper.*—Results of experiments by the author with various metals, such as cast-iron, gun-metal, phosphor-bronze, lead, copper, and type-metal. The object being to determine the cause of the well-known phenomena of the flotation of cold cast-iron on molten cast-iron, and as to whether any expansion took place upon solidification in the metals above noted. 2. Notes of some of the experiments from which the author concludes that the cause of flotation of the solid metal on liquid metal of the same kind is *buoyancy*, due to expansion suddenly set up in the immersed pieces, and that this expansion was found by careful measurement to be at least equal to the shrinkage or total decrease in length of the piece from white hot solid to finally cooled down solid. Further, that the expansion observed is obtained within much lower limits of temperature than the shrinkage; as the pieces, which were in all cases removed from the molten metal, immediately on appearing floating hardly showed redness, and when broken it was found that the crystalline character of the metal remained. 3. Notes of experiments made by gradually heating pieces of cast-iron—the results of all these experiments leading the author to conclude that the *rate* of expansion in cast-iron is at first much more rapid at low temperature than afterwards at high temperature. 4. From experiments carried on with pieces of lead and copper and type-metal, it was found that if any flotation occurred it was only with small light pieces—heavy pieces sinking and remaining at bottom of ladle. Gun-metal and phosphor-bronze behaved like cast-iron. 5. Consideration of the peculiar appearance, or "*break*," observed on the surface of molten cast-iron, the figures presenting a geometrical pattern, like interlacing circles or stars. The author believes that this appearance is due to cracks forming upon the rapidly forming skin—these cracks taking more or less a circular form from the convex forms into which the various parts of the surface are thrown, due to the bubbling up of gas or air. This appearance is limited to cast-iron, and experienced observers can tell the quality of the iron from the form of pattern or figures showing on the molten surface. 6. From observation and experiments carried out from time to time, the author concludes that no perceptible increase of volume of the metals noted occurs at the moment of solidification; at least when free from air or gas confined within the casting.

[1] Temperature probably much too low. The wire, sagging down, touched the inside of the glass tube in several points.

On a Gyrostatic Working Model of the Magnetic Compass, by Sir William Thomson.—In my communication to the British Association at Southport,[1] I explained several methods for overcoming the difficulties which had rendered nugatory, I believe, all previous attempts to realise Foucault's beautiful idea of discovering with perfect definiteness the earth's rotational motion by means of the gyroscope. One of these, which I had actually myself put in practice with partially satisfactory results, was a

Gyrostatic Balance for Measuring the Vertical Component of the Earth's Rotation.

It consisted of one of my gyrostats supported on knife-edges attached to its containing case, with their line perpendicular to the axis of the interior fly-wheel and above the centre of gravity of the fly-wheel and framework by an exceedingly small height, when the framework is held with the axis of the fly-wheel and the line of knife-edges both horizontal, and the knife-edges downwards in proper position for performing their function. The apparatus, when supported on its knife-edges with the fly-wheel not spinning, may be dealt with as the beam of an ordinary balance. Let now the framework bear two small knife-edges, or knife-edged holes, like those of the beam of an ordinary balance, giving bearing-points for weights in a line, cutting the line of the knife-edges as nearly as possible, and of course (unless there is reason to the contrary in the shape of the framework) approximately perpendicular to this line, and, for convenience of putting on and off weights, hang, as in an ordinary balance, two very light pans by hooks on these edges in the usual way. Now, with the fly-wheel not running, adjust by weights in the pans if necessary, so that the framework rests in equilibrium in a certain marked position with the axis of rotation inclined slightly to the horizontal, in order that the axis of the fly-wheel, whether spinning or at rest, may always slip down so as to press on one and not on the other of the two end plates belonging to its two ends. Now, unhook the pans and take away the gyrostat and spin it; replace it on its knife-edges, hang on the two pans, and find the weight required to balance it in the marked position with the fly-wheel now rotating rapidly. This weight, by an obvious formula which was placed before the Section at Southport, gives an accurate measure of the vertical component of the earth's rotation.[2]

Gyrostatic Model of the Dipping Needle

I also showed at Southport that the gyrostatic balance described above, if modified by fixing the knife-edges, with their line passing as accurately as possible through the centre of gravity of the fly-wheel and framework, and with the faces of the knives so placed that they shall perform their function properly when the axis of the fly-wheel is parallel to the earth's axis of rotation, and the rotation of the fly-wheel in the same direction as the earth's, will act just as does an ordinary magnetic dipping needle; but showing latitude instead of dip, and dipping the south end of the axis downwards instead of the end that is

[1] No report of this communication has, so far as I know, hitherto appeared in print.

[2] The formula is

$$gw = \frac{1}{a} W k^2 \omega \gamma \sin l;$$

where w denotes the balancing weight; gw the force of gravity upon it; a the arm on which this force acts; W the weight of the fly-wheel; k its radius of gyration; ω its angular velocity; γ the earth's angular velocity; and l the latitude of the place.

towards the north as does the magnetic dipping needle. Thus, if the bearing of the knife-edges be placed east and west, the gyrostat will balance with its axis parallel to the earth's axis, and therefore dipping with its south end downwards in northern latitudes and its north end downwards in southern latitudes. If displaced from this position and left to itself, it will oscillate according to precisely the same law as that by which the magnetic needle oscillates. If the bearings be turned round in azimuth, the position of equilibrium will follow the same law as does that of a magnetic dipping needle similarly dealt with. Thus, if the line of knife-edges be north and south, the gyrostat will balance with the axis of the fly-wheel vertical, and if displaced from this position will oscillate still according to the same law; but with directive couple equal to the sine of the latitude into the directive couple experienced when the line of knife-edges is east and west. Thus this piece of apparatus gives us the means of definitely measuring the direction of the earth's rotation, and the angular velocity of the rotation. These experiments will, I believe, be very easily performed, although I have not myself hitherto found time to try them.

Gyrostatic Model of a Magnetic Compass

At Southport I showed that a gyrostat supported frictionlessly on a fixed vertical axis, with the axis of the fly-wheel horizontal or nearly so, will act just as does the magnetic compass, but with reference to "astronomical north" (that is to say, rotational north) instead of "magnetic north." I also showed a method of mounting a gyrostat so as to leave it free to turn round a truly vertical axis, impeded by so little of frictional influence as not to prevent the realisation of the idea. The method, however, promised to be somewhat troublesome, and I have since found that the object of producing a gyrostatic model of the magnetic compass may, with a very remarkable dynamical modification, be much more simply attained by merely suspending the gyrostat by a very long, fine wire, or even by floating it with sufficient stability on a properly planned floater. To investigate the theory of this arrangement let us first suppose a gyrostat, with the axis of its fly-wheel horizontal, to be hung by a very fine wire attached to its framework at a point, as far as can conveniently be arranged for, above the centre of gravity of fly-wheel and framework, and let the upper end of the wire be attached to a torsion head, capable of being turned round a fixed vertical axis as in a Coulomb's torsion balance. First, for simplicity, let us suppose the earth to be not rotating. The fly-wheel being set into rapid rotation, let the gyrostat be hung by the wire, and after being steadied as carefully as possible by hand, let it be left to itself. If it be observed to commence turning azimuthally in either direction, check this motion by the torsion head; that is to say, turn the torsion head gently in a direction opposite to the observed azimuthal motion until this motion ceases. Then do nothing to the torsion head, and observe if a reverse azimuthal motion supervenes. If it does, check this motion also by opposing it by torsion, but more gently than before. Go on until when the torsion head is left untouched the gyrostat remains at rest. The process gone through will have been undistinguishable from what would have had to be performed if, instead of the gyrostat with its rotating fly-wheel, a rigid body of the same weight, but with much greater moment of inertia about the vertical axis, had been in its place. The formula for the augmented moment of inertia is as follows. Denote by—

- W, the whole suspended weight of fly-wheel and framework;
- K, the radius of gyration round the vertical through the centre of gravity of the whole mass regarded for a moment as one rigid body;
- w, the mass of the fly-wheel;
- k, the radius of gyration of the fly-wheel;
- a, the distance of the point of attachment of the wire above the centre of gravity of fly-wheel and framework;
- g, the force of gravity on unit mass;
- ω, the angular velocity of the fly-wheel; the virtual moment of inertia round a vertical axis is

$$WK^2\left(1 + \frac{w^2 k^4 \omega^2}{W^2 K^2 ag}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The proof is very easy. Here it is. Denote by—

- ϕ, the angle between a fixed vertical plane and the vertical plane containing the axle of the fly-wheel at any time t;
- θ, the angle (supposed to be infinitely small and in the plane of ϕ), at which the line a is inclined to the vertical at time t;
- H, the moment of the torque round the vertical axis exerted by the bearing wire on the suspended fly-wheel and framework.

By the law of generation of moment of momentum round an axis perpendicular to the axis of rotation requisite to turn the axis of rotation with an angular velocity $d\phi/dt$, we have

$$wk^2\omega \frac{d\phi}{dt} = gWa\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

because $gWa\theta$ is the moment of the couple in the vertical plane through the axis by which the angular motion $d\phi/dt$ in the horizontal plane is produced. Again, by the same principle of generation of moment of momentum taken in connection with the elementary principle of acceleration of angular velocity, we have

$$wk^2\omega \frac{d\theta}{dt} + WK^2 \frac{d^2\phi}{dt^2} = H \quad . \quad . \quad . \quad . \quad (3)$$

Eliminating θ between these equations we find

$$\left(\frac{w^2 k^4 \omega^2}{gWa} + WK^2\right)\frac{d^2\phi}{dt^2} = H \quad . \quad . \quad . \quad (4)$$

which proves that the action of H in generating azimuthal motion is the same as it would be if a single rigid body of moment of inertia given by the formula (1), as said above, were substituted for the gyrostat. Now to realise the gyrostatic model compass: arrange a gyrostat according to the preceding description with a very fine steel bearing wire, not less than 5 or 10 metres long (the longer the better; the loftiest sufficiently sheltered inclosure conveniently available should be chosen for the experiment). Proceed precisely as above to bring the gyrostat to rest by aid of the torsion head, attached to a beam of the roof or other convenient support sharing the earth's actual rotation. Suppose for a moment the locality of the experiment to be either the North or South Pole, the operation to be performed to bring the gyrostat to rest will not be discoverably different from what it was, as we first imagined it when the earth was supposed to be not rotating. The only difference will be that, when the gyrostat hangs at rest, relatively to the earth, θ will have a very small constant value; so small that the inclination of a to the vertical will be quite imperceptible, unless a were made so exceedingly small that the arrangement should give the result, to discover which was the object of the gyrostatic model balance described above; that is to say, to discover the vertical component of the earth's rotation. In reality we have made a as large as we conveniently can; and its inclination to the vertical will therefore be very small, when the moment of the tension of the wire round a horizontal axis perpendicular to the axis of rotation of the fly-wheel is just sufficient to cause the axis of the fly-wheel to turn round with the earth. Let now the locality be anywhere except at the North or South Pole; and now, instead of bringing the gyrostat to rest at random in any position, bring it to rest by successive trials in a position in which, judging by the torsion head and the position of the gyrostat, we see that there is no torsion of the wire. In this position the axis of the gyrostat will be in the north and south line, and, the equilibrium being stable, the direction of rotation of the fly-wheel must be the same as that of the compotent rotation of the earth round the north and south horizontal line, unless (which is a case to be avoided in practice) the torsional rigidity of the wire is so great as to convert into stability the instability which, with zero torsional rigidity, the rotational influence would produce in respect to the equilibrium of the gyrostat with its axis reversed from the position of gyrostatic stability. It may be remarked, however, that even though the torsional rigidity were so great that there were two stable positions with no twist, the position of gyrostatic unstable equilibrium made stable by torsion would not be that arrived at: the position of stable gyrostatic equilibrium, rendered more stable by torsion, would be the position arrived at, by the natural process of turning the torsion head always in the direction of finding by trial a position of stable equilibrium with the wire untwisted by manipulation of the torsion head. Now by manipulating the torsion head bring the gyrostat into equilibrium with its axis inclined at any angle, ϕ, to that position in which the bearing wire is untwisted; it will be found that the torque required to balance it in any oblique position will be proportional to the sin ϕ. The chief difficulty in realising this description results from the great augmentation of virtual moment of inertia, represented by the formula (1) above. The paper at present communicated to the Section contains calculations on this subject, which throw light on many of the practical difficulties hitherto felt in any method of carrying out gyrostatic investigation of the earth's rotation, and which have led the author to fall back upon the method described by him at Southport, of which the essential characteristic is to constrain the frame of the gyrostat in such a manner as to leave it just one degree of freedom to move. The paper concludes with the description of a simplified manner of realising this condition for a gyrostatic compass—that is to say, a gyrostat free to rotate about an axis either rigorously or very approximately vertical.

Section C—Geology

On Ice-Age Theories, by Rev. E. Hill, M.A., F.G.S., Tutor of St. John's College, Cambridge.—On the Montreal Mountain, in the neighbouring quarries, at the mouth of the Saguenay River, and more or less everywhere over all Canada and all the north and north-west of this continent, are seen phenomena which imply a former vastly extended action of ice. The like are found over Europe and Asia, thus completely encircling the Pole. Many theories have been propounded to account for these facts. It is proposed to pass these before you in review. Any explanation ought to account not only for cold greater than the present, but for accumulations of snow and ice. A kindred phenomenon is the greater size of the Antarctic ice-cap. The supposed interglacial warm periods, and the unquestioned luxuriance of Miocene vegetation in Greenland, ought also to find their causes in any thoroughly satisfactory theory. The theories which have been propounded fall into three groups, as Cosmical, Terrestrial, and Astronomical (or Periodical). The Cosmical theories are Poisson's Cold-Space theory—incomprehensible; and the Cold-Sun theory of S. V. Wood and others—lacking any evidence. The Terrestrial theories are numerous. Lyell's suggestion of Polar-continent and Equatorial-ocean is opposed by evidence that continents and oceans lay on much the same areas as now. The contrary view, Polar-ocean and Equatorial-land, would deserve consideration but for the same opposing evidence. The elevation view (Dana, Wallace), which alleges greater altitude of mountain-chains, disagrees with the strong evidence for land-depression during the period. The submergence view of Dr. Dawson agrees with this evidence, but requires elucidation. Alteration of ocean-currents (Gunn, J. S. Gardiner) is a most powerful agency, but would act locally rather than universally round the Pole. Alteration of prevalent winds, hitherto worked out by no one, deserves attentive consideration. Conditions are conceivable which would produce over an area winds from cold quarters almost permanently. However, this seems open to the same objection as the preceding theory. Last come the Astronomical or Periodical theories. A tilt of the earth's axis was suggested by Belt, but suggested as owing to causes which are wholly insufficient. Tilting from astronomical agencies is slight, though its action would be in the direction required. Herschel suggested the Eccentricity theory, but abandoned it. Adhémar's Precession theory, as explained by himself, involved an absolute fallacy. The celebrated view of Dr. Croll combines the Precession and Eccentricity theories into one. It exactly agrees with the Antarctic greater extension of ice, and provides an explanation of interglacial warm periods. The great difficulty in its way is to see how a mere difference in distribution through the year of an unchanged total heat-receipt can produce consequences so vast. The laws of radiation explain but a very minute part, the laws of evaporation perhaps rather more; but, so far as can at present be seen, both together are inadequate. Another serious objection is that the theory seems to require the climate of the northern hemisphere to be now in a state of change for the better, of which at present there appears no evidence. Dr. Croll's elaborate explanations of the reaction of one effect upon another—fogs, deflection of currents, and the like—have no special connection with his own theory. They would act in all cases, and support all theories equally. The arguments, if admitted, would only prove that the earth's climates are in a state of highly unstable equilibrium, in which a slight cause may produce an enormous change. Nor are his arguments universally admitted. In conclusion, Dr. Croll's theory seems inadequate: alteration of currents and winds are the most powerful causes suggested hitherto: further investigations ought to be made as to the nature and extent of the last series of changes in the outlines of the continents of the globe.

What is a Mineral Vein or Lode? by C. Le Neve Foster, B.A., D.Sc., F.G.S., H.M. Inspector of Mines.—The author quoted briefly the definitions of a mineral vein given by Werner, Carne, Von Cotta, Grimm, Von Groddeck, Geikie, Sandberger, and Serlo, who, in common with most geologists, have looked upon mineral veins as "the contents of fissures." While admitting that a very large number of veins may be so described, the author contended that the exceptions are sufficiently important and numerous to warrant a change in the definition. He is of opinion that many of the principal and most productive tin-lodes in Cornwall are simply tabular masses of altered granite adjacent to fissures; and he brought forward the opinions of other geologists to show that certain veins in the English Lake district, the Tyrol, Nova Scotia, Nevada, Colorado, California, and Australia, are not filled-up fissures. In conclusion, he proposed the following definition: "A mineral vein or lode is a tabular mineral mass formed, more or less entirely, subsequently to the inclosing rocks."

The Acadian Basin in American Geology, by L. W. Bailey, Geological Survey of Canada.—The Acadian Basin, embracing the region bordering on and including the Gulf of St. Lawrence, together with the provinces of New Brunswick, Nova Scotia, Newfoundland, and Prince Edward Island, constitutes one of the natural physical divisions of the continent of North America, and exhibits many marked peculiarities of climate and floral and faunal distribution. In its geological structure, and in the history which this reveals, its individuality is not less clearly marked, being often in strong contrast with that of other portions of the continent farther west; and in some periods and features even exhibiting a closer relationship with the geology of Europe. In the present paper, the facts bearing upon this individuality are summarised and discussed; including the consideration of the varying land-surfaces of Acadia in different eras, the time and nature of its physical movements, its climate, and its life. A review of recent progress in the investigation of its geological structure is also given.

Upon the Improbability of the Theory that former Glacial Periods in the Northern Hemisphere were due to Eccentricity of the Earth's Orbit, and to its Winter Perihelion in the North, by W. F. Stanley, F.G.S., F.R.Met.S.—The theory of Dr. Croll, accepted by many geologists, is that former glacial periods in the northern hemisphere were due to greater eccentricity of the earth's orbit, and to this hemisphere being at the time of glaciation in winter perihelion. This theory is supported upon conditions that are stated to rule approximately at the present time in the southern hemisphere, which is assumed to be the colder. Recent researches by Ferrel and Dr. Hann, with the aid of temperature observations taken by the recent Transit of Venus expeditions, have shown that the mean temperature of the southern hemisphere is equal to, if not higher than the northern, the proportions being 15·4 southern and 15·3 northern. The conditions that rule in the south at the present time are a limited frozen area about the South Pole, not exceeding the sixtieth parallel of latitude; whereas in the north frozen ground in certain districts, as in Siberia and North-Western Canada, extends beyond the fiftieth parallel; therefore by comparison the north, as regards the latitude in which Great Britain is situated, is at present the most glaciated hemisphere. As it is very difficult to conceive that the earth had at any former period a lower initial temperature, or that the sun possessed less heating power, glaciation in the north could never have depended upon the conditions argued in Dr. Croll's theory. The author suggested that glaciation within latitudes between 40° to 60° was probably at all periods a local phenomenon depending upon the direction taken by aërial and oceanic currents; as, for instance, Greenland is at present glaciated, Norway has a mild climate in the same latitude, the one being situated in the predominating northern Atlantic currents, the other in the southern. Certain physical changes suggested in the distribution of land would reverse these conditions and render Greenland the warmer climate, Norway the colder.

On the Occurrence of the Norwegian "Apatitbringer" in Canada, with a few Notes on the Microscopic Characters of some Laurentian Amphibolites, by Frank D. Adams, M.Ap.Sc., Assistant Chemist and Lithologist to the Geological Survey of Canada.—The paper first gives a short account of the investigations which have been made on this amphibole-scapolite rock in Norway, where all the principal deposits of apatite either traverse it or occur in its immediate vicinity. The deposits of apatite in Canada generally occur associated with some variety of highly pyroxenic rock, often holding orthoclase and quartz. The "Apatitbringer" has, however, recently been found in the vicinity of the town of Arnprior on the River Ottawa. It closely resembles the Norwegian rock, both in external appearance and in its microscopic characters, containing hornblende, scapolite, and pyroxene as essential constituents. A number of amphibolites in the Museum of the Geological Survey of Canada, which resemble this rock in appearance, have been sliced and examined with the microscope, and one of them found to contain scapolite in large amount. It was collected at Mazinaw Lake, in the township of Abinger, and is from the same belt of hornblendic rocks as that in which Arnprior is situated. The paper closes with a short account of some of these amphibolites.

The Geological Age of the Acadian Fauna, by G. F. Matthew, A.M., F.R.S.C.—In this sketch an attempt is made, by comparison with the Cambrian fauna of other countries, and especially of Wales, to fix more exactly than has hitherto been d ne the position of the assemblage of organisms found near the base of the St. John group. The trilobites are taken as a criterion for this purpose. A brief statement of the position and thickness of the beds is given, showing the relation of the fauna to the formation as a whole. It is shown that the genera and species of the Acadian trilobites do not agree with those of the Menevian, in the restricted application of that term now in vogue; the great *Paradoxides* with short eyelobes, and the genera *Anopolenus*, *Agraulos* (= *Arionellus*), *Erinnys*, and *Holocephalina* being, so far as known, absent from it. On the other hand, it shows very close relationships in its genera to the Solva group fauna, especially in the following species:—

Solva Group	Acadian Fauna
Conocoryphe solvensis, Hicks	*Ctenocephalus matthewi*, Hartt sp.
Conocoryphe bufo, Hicks	*Conocoryphe elegans*, Hartt sp.
Paradoxides harknessi, Hicks	*Paradoxides eteminicus*, Matthew

As bearing on the question of the age of the Acadian fauna, the development of the eyelobe in *Paradoxides* is referred to, and it is shown that while in the Cambrian rocks of Wales the length of the eyelobe is in direct relation to the age of the strata, the *Paradoxides* of the Acadian fauna, having continuous or nearly continuous eyelobes, are more primitive in their facies than those of the Menevian, and agree with the species found in the Solva group. The family of Conocoryphidæ, restricting the name to such species as those described by Corda under *Conocoryphe* and *Ctenocephalus*, are a marked feature of this early fauna; and *Conocoryphe* has a characteristic suture not observed in the Menevian genera. The Acadian *Ctenocephalus* also differs in this respect from the Bohemian species.

On the More Ancient Land Floras of the Old and New Worlds, by Principal Dawson, LL.D., F.R.S.—In the Laurentian period vegetable life is probably indicated, on both sides of the Atlantic, by the deposits of graphite found in certain horizons. There is good evidence of the existence of land at the time when these graphitic beds were deposited, but no direct evidence as yet of land plants. The carbon of these beds might have been wholly from subaquatic vegetation; but there is no certainty that it may not have been in part of terrestrial origin, and there are perhaps some chemical arguments in favour of this. The solution of the question depends on the possible discovery of unaltered Laurentian sediments. The Silurian land flora, so far as known, is meag e. The fact that *Eopteris* has been found to be merely a film of pyrite deprives us of the ferns. There remain some verticillately-leaved plants allied to *Annularia*, the humble Acrogens of the genus *Psilophyton*, and the somewhat enigmatical plants of the genera *Pachytheca*, *Prototaxites*, and *Berwynia*, with some uncertain Lycopods. We have thus at least forerunners of the families of the *Arterophyllitæ*, the *Lycopodiaceæ*, and the *Coniferæ*. The comparison of the rich Devonian or Erian flora of the two sides of the Atlantic is very interesting. On both continents it presents three phases—those of the Lower, Middle, and Upper Erian—and there is a remarkable correspondence of these in countries so wide apart as Scotland, Belgium, Canada, Brazil, and Australia. Examples of this were given in the Rhizocarps, at this period very important, in the Lycopods, the Equisetaceæ, the Ferns, and the Conifers. The number of conife ous trees belonging to *Dadoxylon* and allied genera, and the abundance of ferns, often arborescent, were especial features in the Middle and Later Erian. The flora of the Erian age culminated and then diminished. In like manner that of the succeeding Carboniferous period had a small commencement quite distinct in its species from the Erian; it culminated in the rich vegetation of the true coal formation, which was remarkably similar over the whole world, presenting, however, some curious local differences and dividing lines which are beginning to become more manifest as discovery proceeds. In the Upper Carboniferous the flora diminishes in richness, and the Permian age is, so far as known, one of decadence rather than of new forms. Great progress has recently been made by Williamson and others in unravelling the affinities of the coal-formation plants, and we are on the eve of great discoveries in this field. Throughout the Silurian the conditions do not seem to have been eminently favourable to plants, but the few forms known indicate two types of Acrogens, and one leading to the Gymnosperms, and there is no reason to doubt the existence of insular land richly clothed at least with the few forms of vegetation known to have existed. In the Erian and Carboniferous there seem to have been two great waves of plant-life, proceeding over the continents from the north, and separated by an interval of comparative sterility. But no very material advance was made in them, so that the flora of the whole Palæozoic period presents a great unity and even monotony of forms, and is ve y distinct from that of succeeding times. Still the leading families of the *Rhizocarpeæ*, *Equisetaceæ*, *Lycopodiaceæ*, *Filices*, and *Coniferæ*, established in Palæozoic times, still remain; and the changes which have occurred consist mainly in the degradation of the three first-named families, and in the introduction of new types of Gymnosperms and Phænogams. These changes, delayed and scarcely perceptible in the Permian and Early Mesozoic, seem to have been greatly accelerated in the Later Mesozoic.

On the Structure of English and American Carboniferous Coals, by Edward Wethered, F.G.S., F.C.S.—The author had examined several seams of coal from England and America. He pointed out that they were not always made up of one continuous bed of coal, but often comprised several distinct beds. In the case of the well-known Welsh "four-feet" seam there were four distinct strata of coals, separated by clay beds of a few inches thick. In the case of the "splint coal" from Whitehill Colliery, near Edinburgh, the seam presented three clearly-defined beds of coal, but these were not separated by partings of any kind. With a view of testing the "Spore theory" of the origin of coal, as propounded by Prof. Huxley, the author had obtained a portion of the "better-bed" seam intact for a thickness of 10 inches from the top. He had examined this inch by inch, by preparing thirty-three microscopic sections. At the top were $3\frac{1}{2}$ inches of dull lustrous coal, termed "laminated coal." This the author found to be practically a mass of macrospores and microspores. Below this there was a change in the character of the seam. Spores became less numerous; in places they were scarce, the mass being made up of vegetable tissue and a substance to which the author gives the term "hydrocarbon." He could not, therefore, support Prof. Huxley in saying that the "better-bed" coal was "simply the sporangia and spore-cases of plants." The assertion would, however, apply to the first $3\frac{1}{2}$ inches of the seam. The "splint coal" from Whitehill Colliery was a better example of a spore coal than the "better-bed." The bottom stratum was 4 inches thick, and presented a dull lustre, with thin bright layers traversing at intervals. The dull portion was a mass of spores and spore-cases, but these did not enter the bright layers. A vertical section cutting a bright layer, bounded on either side by dull lustrous coal, showed plenty of spores in the dull coal, but in the bright not one was detected. The second bed in this seam was 1 foot thick; it was of a brighter lustre than the 4 inches below, but two layers could be distinctly made out, one more lustrous than the other. In the dullest of the two, spores were found, which, however, were less numerous than in the bed below, and were also of a different variety. In the bright layers the spores were absent. The top bed of the seam was also 1 foot thick, and might be defined as a mass of spores, chiefly microspores, except in the bright layers. The American coals examined were collected by the author from the Warrior Coalfields of Alabama, and from near Pittsburg, Pennsylvania. The same structural affinities were noticed as in the English coals, and the author therefore came to the conclusion that the English and American Carboniferous coals had a common origin. The spores in the coal from both countries were closely allied. Some microspores from Alabama were identical with those which occur in the lower bed of the Welsh "four-feet" seam. A feature in spores obtained from all the coals was the triradiate markings which they exhibited. Whether this was to be regarded as superficial or not, it was very characteristic of them, and was therefore to be considered in attempting to ally them with modern vegetation. The author regarded peat in the light of post-Tertiary coal; lignite as peat in a transition state to coal; and coal as the remains of Carboniferous bogs. The author referred to the practical application of a knowledge of the microscopic structure of coal, as enabling an expert to judge of the nature of a coal from an examination of it with a pocket lens.

Points of Dissimilarity and Resemblance between Acadian and Scottish Glacial Beds, by Ralph Richardson, F.R.S.E., V.P. G.S.Edinb.—Mr. Richardson said that, in his "Acadian Geology," Principal Dawson gave the following as a typical section of the superficial geology of Acadia—that is, Nova Scotia, New Brunswick, and Prince Edward Island—and as, in some respects, also applicable to Canada and Maine, viz.: At the bottom, peaty deposits; then unstratified Boulder Clay; then stratified Leda Clay, indicating deep water; and, lastly, gravel and sand beds, the Saxicava sand indicating shallow water. Mr. Richardson pointed out wherein such a section differed from and resembled the glacial beds of Scotland. He said the latter showed no such orderly arrangement as the Acadian, and could not, as a rule, be divided into deep and shallow water-beds. The marine shells in the Scottish beds are all mixed up together, regardless, as a rule, of the province—whether Arctic or British, or both—to which they properly belong, regardless of the depths which they usually tenant, and regardless of the deposit (whether clay, gravel, or sand) in which they are now found fossil. They are likewise met with at all heights, from the level of the sea to more than 500 feet above it. No system of dispersion of boulder-erratics from definite centres in Scotland seems as yet ascertained. The peaty deposits, occurring in Principal Dawson's section *below* the Boulder Clay or till, occur in Scotland above it. With regard to points of resemblance, the facies of the shells in Acadia and Scotland is similar, being of the Arctic and British-Arctic type. Again, both in Acadia and Scotland, all the fossiliferous glacial beds occur above the unstratified Boulder Clay or till. Mr. Richardson cited various Scottish sections to prove this, and remarked that the belief in earlier and later Boulder Clays is of long standing in Scotland. He concluded by pointing out that, in their cardinal features, the Acadian and Scottish glacial beds seemed to coincide. In both Acadia and Scotland that great mass of unstratified clay known as *till* existed; and doubtless the geologists of the New World were, like those of the Old, puzzled to account for its origin with certainty and satisfaction. The question was left unsolved by the meeting of the British Association in Edinburgh in 1850; although then discussed by Hugh Miller and Prof. John Fleming. The author hoped that during the present meeting some advance would be made in solving this great problem, as well as in correlating and arranging the glacial beds of Canada, Acadia, and Britain.

On the Mode of Occurrence of Precious Stones and Metals in India, by V. Ball, M.A., F.R.S.—For full 3000 years India has been known as the source of precious stones and metals, but scarcely 200 years have elapsed since other countries yielding precious stones have entered into competition with her; and it is only within the present century that she has ceased to hold a pre-eminent position as a supplier of the markets of the world. In order to arrive at a full and satisfactory elucidation of this subject, two branches of inquiry must be undertaken—one based upon what has been actually ascertained by careful geological exploration of the country, and the other upon such historical records as are available of the former production of the minerals in question, and of the indications of the sites where they were mined. By means of our present knowledge of the geology, it has become possible to give definite form to many vague statements by early writers, and to recognise the actual positions of mines which are now, by the people of the localities themselves, forgotten and deserted. In the majority of these cases, had the geologist not got the historical hand to guide him, he would be unwilling to predicate the presence of such minerals from mere superficial examination. As a collateral result, many of the widespread myths and fables connected with mining have proved to have originated in peculiar local customs. They rest, therefore, on more substantial bases of facts than could have been suspected by any one unacquainted with these customs. This method of combining the results of geological research with historical records the author has found on previous occasions to have the advantage of bringing the geologist into touch with the rest of humanity, arranging as it does the interest of historians, linguists, and others, who find in the facts so presented to them pabulum applicable to the requirements of their own particular pursuits. In this paper it will not be necessary or suitable to enter at length into details—the author having done so elsewhere.[1] His object is rather to direct attention to the subject generally, and to make known the fact that much has been accomplished of late years which has not as yet found its way into manuals and encyclopædias. Most of the information to be found in such works is far behind our present knowledge; and, where not actually incorrect, has been superseded by fuller and more accurate observations. The subjects taken for special consideration are the following:—Diamond, ruby, sapphire, spinel, beryl, emerald, lapis-lazuli, gold, silver. The steel of India, or *wootz*, might be included here, since, at least 2000 years ago, it was one of the most precious productions of India.

On the Relative Ages of the American and the English Cretaceous and Eocene Series, by J. Starkie Gardner, F.L.S., F.G.S.—The paper is a contribution towards the determination of the ages of the American Cretaceo-Eocene rocks, relative to those of Europe. It briefly describes the chief characteristics of the various stages of the series in America. The lowest beds there are distinguished by the presence of well-developed dicotyledonous leaves, associated with *Ammonites* and other Cretaceous Mollusca, considered to warrant their correlation with the Gault and Chalk of England. Newer beds thought to be intermediate in age between Secondary and Tertiary are distinguished by the incoming of palms and a new flora of Dicotyledons, associated with *Mosasaurus*. The rest are correlated with the various divisions of the Tertiary series recognised in Europe. The entire series seems to have been deposited without any considerable break in continuity, but reveals a sudden transition from a temperate to a subtropical flora, and from a Cretaceous to a Tertiary Vertebrata. The high development of the flora is, however, quite irreconcilable with the accepted correlation. In further comparing the American series with that of Europe, it is observed that the subdivisions of the Cretaceous series were first determined for a limited area, when different ideas of evolution and gradual passage prevailed, and subsequently extended to embrace areas at a distance which may be, rightly or wrongly, correlated with those of England and Western France. The comparisons now drawn are only between the rocks of the original and typical area and of America, excluding the Cretaceous rocks of other countries. Thus restricted, the Neocomian of Europe comprises only shore deposits, characterised by a Cretaceo-Jurassic fauna and a Jurassic flora. The Gault is a deeper sea-deposit, comparable to the "Blue Mud" of the *Challenger*, with a typically Cretaceous fauna and a Jurassic flora. The Upper Greensands are more or less the equivalents of the Gault, deposited under differing physical conditions, corresponding to the "Greensands" of the *Challenger*, and have been assumed to represent the shore or shallower water conditions preceding the Chalk. The Chalk itself is described with a view to prove that it is a truly oceanic deposit, formed at a distance from shore and at a considerable depth, corresponding in all respects with the existing "Globigerina Ooze." The arguments against this view are refuted in detail, and the suggestion made that the alleged shallower habitats in the tropics of the few surviving Mollusca may be due to the lower temperature prevailing now in the abyssal depths of the ocean having driven heat-loving types from the depths at which they were able to live in the Chalk period. The whole Cretaceous series in the British area is the result of a gradual conversion of land into sea, owing to subsidence. The process commenced with the Neocomian, became more serious with the Gault, and continued until the close of the Chalk. The focus of the depression, so far as its results are accessible, was the English Channel, whence it spread in an easterly direction across Central Europe. As the land subsided, the gulf increased in magnitude, and Blue and Green Muds were formed on a wider and wider area, to be succeeded in due time by chalky Ooze. The nearer the focus of subsidence the older the Greensands and Gault, and the farther we recede from it the newer in age they become. The zones of increasing depth travelled outward and forward, and though now represented by continuous bands of the same lithological characters, extending over many countries, it would be rash in the extreme to infer the synchronism of portions of these when separated by degrees of latitude. The time required for these zones to travel from Kent to the Crimea, and to accumulate a mass, mainly composed of minute organisms, of over a thousand feet in thickness, must have been sufficient to account

[1] "Economic Geology of India," and "A Geologist's Contribution to the History of India," *Proc. Roy. Dub. Soc.* 1883.

for a very sensible progress in the evolution of organic forms. The deposition of the Chalk commenced in the English area at a period when the land floras were still of Jurassic character. By the time it had reached Limburg, Saxony, and Bohemia, Dicotyledons had become developed. The period required for the chalk ocean to encroach but 300 to 400 miles must thus have been very vast. The question may, however, arise whether plant development at this stage followed the otherwise universal law of evolution, or was exceptionally rapid. The fauna has to be examined to see whether it discloses an equally appreciable progress. The conclusion arrived at is that while the groups with which the author is less acquainted apparently do so, the progress in the Mollusca is unmistakable. The helicoid, turbinate, and patelloid groups are archaic and stationary, but the fusiform shells betray a tendency to elongate their canals, and the relative abundance of such, and gradual dropping out of now extinct genera, furnish an unmistakable index of the relative ages of the more littoral deposits. From this point of view we are able to demonstrate that the Greensands of Aix-la-Chapelle are far younger than their lithological structure and sequence would indicate, while the appearance of such distinctly new developments as cone and cowry shells further support the views of the relatively almost Tertiary, or, at least, transition, age of the Cretaceous series in Denmark. While, therefore, denudation on a truly colossal scale has produced one of the most considerable gaps in the whole geological record between Cretaceous and Tertiary over the British area, beds of intermediate age may successfully be sought for at a distance from this centre. The erroneous correlation of these, bed by bed almost, with the typical Cretaceous series, as developed in England, has led to a still more untrustworthy correlation of the American series with ours. The Cretaceous series of America contains at its very base a flora composed of angiosperms so perfectly differentiated that they are apparently referable to existing genera. One of the oldest floras in Europe containing angiosperms is that of Aix-la-Chapelle, and even this we have seen is relatively modern; but these are not referable in at all an equal degree to existing genera, and even the Coniferæ are embarrassing on account of their highly transitional characters. The oldest Cretaceous flora of America, so far from possessing any Cretaceous characters, agrees in a remarkable manner with that of the English Lower Eocene, while the Laramie, or supposed Cretaceo-Eocene, flora has very much in common with that of our Middle Eocene, and marks a similarly sudden rise in temperature. The question is whether the evidence of the fauna in favour of the Cretaceous age of the series is so conclusive that the floral evidence must be set aside. Taking the Cretaceous series as represented in California, the older stages possess Mollusca of definitely Cretaceous aspect, but those of the newest have a decidedly Eocene facies. To be Cretaceous a fauna must have some elements which did not survive to a later period; but are we in a position to state that the Ammonitidæ, the Belemnites, and Inocerami did not do so? Even our present limited knowledge is entirely opposed to such a view. It must be remembered that the Eocenes in their typical area, England and France, were deposited under peculiar local conditions, and it would be as logical to infer from the absence in them of Cretaceous types that these existed nowhere else as it would be were the bed of the English Channel now upheaved to class as extinct all forms of life not met with in its sands and muds. If, as there is evidence to show, America was isolated at the time, the survival there of forms of Reptilia elsewhere extinct would be in accordance with ordinary observation at the present day. The flora of the American series is Eocene; the fauna of its earlier stages is Cretaceous. We are compelled therefore to choose whether we will believe that a large Eocene flora was developed there during the Cretaceous, or that some members of a Cretaceous fauna lived on to an Eocene date. The former supposition demands greater rapidity of evolution than we are accustomed to admit, and no external evidence is advanced to support it. The latter is more conceivable from the standpoint of evolution, and is not contradicted by any evidence that has yet come under the author's observation.

On Some Remains of Fish from the Upper Silurian Rocks of Pennsylvania, by Prof. E. W. Claypole, B.A., B.Sc. (London), F.G.S., of the Second Geological Survey of Pennsylvania.—The earliest vertebrate animals yet known from any part of the world are some remains of fish in the Upper Silurian rocks of England. They are for the most part of three types. First, short fin-spines, named by Agassiz *Onchus tenuistriatus*; second, fragments of shagreen, or the skin of a placoid fish (*Thelodus* and *Sphagodus*), belonging probably to the same that carried the spine; and third, ovate, finely striated plates or shields, supposed to be the defensive armour of some fish, unlike any now living. No one has doubted the ichthyic nature of the first and second of these three forms. But as regards the third there has been much controversy. Evidently allied to *Cephalaspis*, its right to the name of fish has been called in question, and suspicion has been raised in regard to the whole family of the Cephalaspids. On the whole, however, it seems best to retain them in the class of fishes, and to this conclusion Prof. Huxley evidently inclines in the conclusion of his "Essay on the Classification of the Devonian Fish." One may expect some, or even considerable, divergence of structure from the usual ichthyic types in such early forms. These English fossils occur in the lowest beds of the Devonian (Cornwall), and in the highest beds of the Silurian (Shropshire and Hereford). The well-known Upper Ludlow "bone bed" has yielded them in considerable quantity, and one specimen is reported by Sir C. Lyell in his "Elements of Geology" (1865) as discovered from the Lower Ludlow, beneath the Aymestry limestone. Below this horizon I have never heard of their occurrence. The English Ludlow, taken as a whole, has been usually correlated with the Lower Helderberg of North America, and on good grounds, both containing *Eurypterus* and *Pterygotus*. The English Lower Ludlow and the Water-Lime or basal beds of the North-American Lower Helderberg are the lowest strata containing these fossils. On both sides of the Atlantic they range from this level upwards into the Devonian. The oldest vertebrate fossils yet announced from America are those found in the Corniferous limestone or Lowest Devonian of Ohio. Possibly the beds at Gaspé, on the Gulf of St. Lawrence, are somewhat lower, as they have yielded *Cephalaspis*, which is not yet known from Ohio, and *Coccosteus*, of which Ohio has yielded only a single specimen. No authenticated fish-fossil has yet been announced from the Upper Silurian rocks of America. It is true that reports of the discovery of such remains have been published at various times, but investigation has proved them all erroneous. (See "Palæontology of New York," vol. ii. pp. 319, 320, pl. lxxi.; *American Journal of Science*, second series, vol. i. p. 62; "Palæontology of Ohio," vol. ii. p. 262.) During my recent work on the palæontology of Perry County, Pennsylvania, I came upon some fossils which at once suggested relationship to the Ludlow group above described. Among them were a few spines recalling *Onchus tenuistriatus*, but with some differences. I have named them *Onchus pennyslvanicus*. With them I discovered abundance of specimens bearing a strong resemblance to *Pteraspis*, but larger, and differing in some other respects. These I name *Glyptaspis* (*G. elliptica* and *G. bitruncata*). Comparing these with *Pteraspis* we find them much thinner, not exceeding one-tenth of an inch in thickness; whereas specimens of *Pteraspis* in my possession from Cornwall are nearly one-fourth of an inch thick. The striation on both is equally fine, but is rather less regular on the American specimens. These also show no trace of the spine in which the shield of *Pteraspis* terminates, as shown by Murchison in "Siluria." No traces of the English fossil shagreen—*Thelodus* and *Sphagodus*—have been found in the Pennsylvanian beds, though it abounds in the Ludlow rocks. The fossils were found in a bed of sandstone about 200 feet below the base of the water-lime in Perry County, Pennsylvania, near the top of the great mass of variegated shale composing the Fifth Group of Rogers in the First Survey of Pennsylvania. This shale in New York immediately overlies the Niagara limestone, which is correlated on satisfactory evidence with the Wenlock limestone of England. Ten or twelve species are common to the two beds. It seems, therefore, that the great mass of coloured shale, near the top of which these fossils were found, and which is a continuation of the Onondaga group of New York, has no representative in the British series, but corresponds to an interval between the Upper Wenlock and the Lower Ludlow. (For details regarding the correlation of these beds in Pennsylvania with those in New York, see a paper by the author in *Proc. Amer. Phil. Soc.* for 1884.) It is consequently a necessary inference that the beds yielding *Glyptaspis* and *Onchus* in Pennsylvania are somewhat older than those containing *Pteraspis* and *Onchus* in England. Microscopic examination of the specimens, and a comparison of their structure with that of *Pteraspis* and *Cephalaspis* are in progress, and the details will be given in the paper. Other fossils in the author's possession indicate the possible existence of fish at a still earlier date, but the material is not yet worked out.

On Fluxion-Structure in Till, by Hugh Miller, A.R.S.M., F.G.S., Geological Survey of England and Wales.—It has long been recognised as one of the characteristics of the till that its long-shaped boulders are striated lengthwise. They have, as it has been concisely expressed, been "launched forward end-on." From the minute and magnifiable striæ upon the smaller (*e.g.* almond-sized) boulders it also appears that these at least have been carried forward, involved in the matrix, and were glaciated chiefly by its particles. Under the microscope these particles exhibit most of the varieties of form and glaciation that are found among larger boulders. The structure of the till in open situations shows that the axes of its stones have been turned by a common force in the direction of glaciation ; it exhibits a rough structure comparable to the fluxion-structure of igneous rocks, the smaller boulders dividing around and apparently drifting past the larger, like the tide round an anchored skiff. These structures, which have been found by the author over many hundreds of square miles, chiefly in the north of England, indicate that at least a surface-layer of the till was dragged along, with a shearing movement of particle upon particle, producing intimate glaciation within its mass. Proofs are adduced that this moving layer was in general a surface-layer only, and that the till did not, as has often been supposed, move forward *en masse*, licking up its additions from beneath. This is the only intelligible explanation of the order (as well as the structure) of the boulder-clays of which the author has any practical knowledge. In up-lying situations, where the drift consists of raw material, fluxion-structures are seldom detected. In sheltered spots they are not generally developed. They are characteristic of well-kneaded till in open situations, liable, however, to obscuration by contortions within the mass. Of twelve experimental attempts made near the watershed of England in East Cumberland, 600–900 feet above the sea, to determine the ice-movement from this structure alone, eight were correct, three indeterminate, and only one misleading. The pressure and movement capable of producing this widespread fluxion-structure seem to have been that of some mass vast and far-spreading—closely investing, slow-moving, and heavily dragging—such as glacier ice. It needs only to be assumed that the confluent glaciers communicated something of their own movement and structure to the ground-moraine below.

On the Southward Ending of a Great Synclinal in the Taconic Range, by James D. Dana, LL.D.—The Taconic Range, which gave the term "Taconic" to geology, lies in Western New England, between Middlebury, in Vermont, on the north, and Salisbury, in Connecticut, on the south. In former papers, published in the *American Journal of Science*, the author has shown, first, that the rocks constituting the range vary as we go from north to south, from roofing-slate and hydromica (or sericite) schist to true chloritic and garnetiferous mica schists ; secondly, that these schists lie mostly in a synclinal or compound synclinal ; thirdly, that the crystalline limestone along the eastern foot is one with that along the western, the limestone passing under the schist as a lower member of the synclinal ; and fourthly, that since the limestone contains in Vermont (according to the discoveries of the Vermont Geological Survey, and also of Mr. A. Wing), and in the State of New York, fossils of the Lower Silurian, ranging from the inferior divisions to the higher, the Taconic schists are probably of the age of the Hudson River group or Llandeilo flags. The author's papers further show that while a large part of the Taconic Range has eastward dip on both the east and west sides, a southern portion about twelve miles long, consisting of Mount Washington in south-western Massachusetts and its continuation into Salisbury, Connecticut, is a broad tray-shaped synclinal, the dips of the two sides being toward one another, like the sides of an ordinary trough. The width of the broad synclinal between the limestone belt on either side is about five miles. As the result of investigation during the last two years, the synclinal character of this Mount Washington part of the Taconic Range is illustrated in the paper by new sections, and by facts connected with the dying out of the great synclinal (or compound synclinal) in the town of Salisbury. The mean height of Mount Washington above the sea-level is about 2000 feet, and above the wide limestone region on either side and to the south, about 1250 feet. The synclinal virtually ends along an east and west line through the village of Lakeville, in the town of Salisbury, where a beautiful lake lies within the limestone area. The surface of the mountain region descends 1000 feet in the southern, or last, three miles ; and in the latitude of Lakeville, the width, as the map presented shows, diminishes abruptly from five miles to a narow neck of six-tenths of a mile. The area south is of limestone, and the neck of schists referred to is hardly 150 feet in height above it. The limestone may in some places be seen emerging from beneath the schist at a small angle ; and at one locality a low oven-shaped anticlinal of limestone has the schist covering all but a narrow portion at top ; the quarrymen had to remove the schist to work at the limestone. Several narrow strips or belts of limestone, S. 15° W. in direction, corresponding with the direction of this part of the range, show out through the sides of the mountain where local anticlinals have had their tops worn off. Further, the dip of the schist over much of the southern slope is southerly and at a small angle, but with many local anticlinals and synclinals. In addition, there are small areas of schist *in the limestone* region, like straggling portions of the dwindled mountain, which appear in general to be remains of local flexures. There is the plainest evidence that the limestone formation of southern and south-eastern Salisbury comes out from beneath the dwindled, flattened-out, and worn-off mountain synclinal. And the reason why this limestone is exposed to view over plains miles in width, east and west of the Taconic Mountain, as well as to the south, is simply this, that the once overlying schist has been removed because in badly broken anticlinals and synclinals. The paper closes with an allusion to the orographic, stratigraphical, and lithological interest of the facts, and to their important bearing on the question of the origin and chronology of certain kinds of crystalline rocks, such as chloritic, garnetiferous, and staurolitic mica schists, as well as others less coarsely crystalline.

The Primitive Conocoryphean, by G. F. Matthew, A.M., F.R.S.C.—Relates to the development of the species *Ctenocephalus matthewi* and other Conocorypheans of the Acadian fauna, and is considered under the three heads, viz., the Development of the Glabella ; the Acquisition of Sensory Organs ; and the Decoration of the Test. Under the first head it is shown that the peculiar glabella of the species above referred to is closely related to the early history of the trilobite. The glabella, in its earliest stage, is very different from that of the adult, and in outline is not unlike that of *Paradoxides ;* it also resembles this species in the position of the ocular fillet. At the next stage the glabella or axial lobe becomes trumpet-shaped, as in *Carausia*, and in the third the glabella proper is developed by the segmentation of the axial lobe : the glabella and ocular fillets now resemble those of *Ptychoparia.* In the following stages the family characters of the Conocorypheans begin to assert themselves, especially the widening of the base of the glabella, the appearance of the canals connected with the ocular ridges, and the development of spines. (2) *The Acquirement of Organs of Sense.*—The ocular fillet appears, in the second stage of growth, as a faint, narrow ridge, close to the anterior marginal fold, and extending but a short distance from the glabella. It is not until the fifth stage of growth that the ramifying branches which spread from the ocular ridge to the anterior margin made their appearance. The ocular lobe and sensory apparatus connected with it are more distinctly visible on the under than on the outer surface of the test, and the canalets connected with the lobe spread over the anterior slopes of the shield, and extend to the anterior margin. In the tuberculated species they connect by hollow spines with the outer surface. In one species they cover a wider space than in the others, extending some distance behind the ocular ridges and over the front of the glabella. (3) *Decoration of the Test.*—In all the Acadian species of this group but one, the surface of the test at maturity is covered with tubercles and spines similar to the surface-markings of *Conocoryphe sulzeri*, &c. In the earliest stages, however, no such tubercles are found, but the surface appears smooth or scabrous. In *Ctenocephalus matthewi* the surface, in the first three stages of growth, appears smooth ; in the fourth, tubercles begin to appear, and about the fifth stage all projecting parts of the test are studded with them. Those on the glabella and frontal lobe are arranged in transverse rows, those on the cheeks in interrupted rows conforming more or less to the periphery of these protuberances. Towards the adult stage these tubercles and spines become more irregular in position and number, conforming in this respect to the law of development in the Ammonites, expounded by Prof. Alphonso Hyatt.

The Value of Detailed Geological Maps in relation to Water-Supply and other Practical Questions, by W. Whitaker, B.A., F.G.S., Geological Survey of England.—Those maps of the Geological Survey of England in which various divisions of the

Drift have been coloured tell us, as a rule, a very different tale from the corresponding sheets in which the Drift is ignored, and it is only these Drift maps that really give us a true idea of the nature of the surface. Indeed in many districts a geological map that does not show the Drift is comparatively useless for most practical purposes, at all events in a populous country like England. Moreover, it is not merely enough to mass Drift as such, but its constituent members should be fairly distinguished, not merely with regard to their classification or relative age, but also as to their composition, whether of clay, loam, or gravel and sand. To illustrate this there are exhibited copies of the two versions of many of the Geological Survey maps of the London Basin, with and without Drift, from which the following important points will be at once seen:—(1) Large tracts, shown as Chalk on one version, really consist, at the surface, of the generally impervious Boulder Clay, whilst over others the Chalk is covered by Brick-earth and Clay-with-flints: all these beds being such as give an aspect to the country very different to what we find where the Chalk is bare. (2) Parts of the wide-spreading area of the London Clay (of the Driftless maps) are really quite altered and deprived of their clayey character, by the sheets, long strips, and more isolated patches of gravel and sand that occur so often, whether along the river-valleys or over the higher plains. (3) The sandy, permeable Crags are in great part hidden by Drift, which, though often consisting of sand and gravel, is sometimes of Boulder Clay. Indeed, so widespread is the Glacial Drift in the greater part of Norfolk and Suffolk, that only a Drift edition of the Geological Survey maps of the eastern parts of those counties has been issued; a map without Drift would necessarily be a work of fiction. To illustrate the important bearing which these Drift maps have on a great question, that of water-supply from the Chalk, the author also exhibits some special maps, which he has made to show the areas over which rain-water has access to the Chalk, as distinguished from those over which the surface-water cannot sink down into the Chalk, or can only do so very partially. These maps will be more particularly noticed in Section G.

Pennsylvania before and after the Elevation of the Appalachian Mountains, by Prof. E. W. Claypole, B.A., B.Sc., F.G.S. Lond.—The paper, of which the following notes are an abstract, is intended as an attempt to handle, in a necessarily imperfect manner, and only to first approximations, a difficult but important and interesting geological subject. The method of treatment is, in the writer's opinion, one that has not hitherto been employed for the same purpose. The object in view is to form some estimate, as near to the truth as possible, of the amount of compression or shortening produced at the surface by the corrugation of the upper layers of the coast into mountain chains, with especial reference to the American Atlantic seaboard. In order to confine the paper within due limits, certain propositions must be taken as proved. The principal of these are:—(1) That central contraction has developed tangential pressure in the crust; (2) that the tangential pressure has produced crumpling of the crust; (3) that to this crumpling are due long ranges of mountains; (4) that the Appalachian Mountains came into being in this manner in the later portion of the Palæozoic era. These admitted, the conclusion necessarily follows that during the formation of the Appalachian Mountains a considerable contraction of the crumpled area ensued, in a direction at right angles to that of the chain. The following points constitute the main features of the paper:—(1) Short account of the great ranges of Pennsylvania, in plan and section, with diagrams; (2) situation and account of the line of section adopted; (3) limitation of the field to a consideration of eleven great ranges—Blue Mountains, Bower Mountains, Conecocheague Mountains, Tuscarora Mountains, W. Shade Mountains, Black Log Mountains, Blue Ridge Mountains, Jack's Mountain, Standing Stone Mountains, Tussey Mountains, Bald Eagle Mountains; (4) Discussion of the different parts of this section—(*a*) the Mountain Region, (*b*) the Cumberland Valley; (5) attempt to estimate or measure the curved line of the crumpled Upper Silurian (Medina) sandstone; (6) inference that the sixty-five miles of the line of section represents about 100 miles of surface previously to the crumpling of the crust and elevation of the mountains; (7) this result, for several reasons, below rather than above the truth; (8) geographical effects of this contraction; (9) development of the fact that such elevation of mountains by tangential pressure involves not only elevation, but considerable horizontal movement; (10) diminution of motion to north-west; (11) a few words on the failure of attempts yet made to account for this contraction; (12) suggestions and conclusions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

At King's College Prof. W. Grylls Adams, F.R.S., will deliver a course of lectures on Electricity and Magnetism and their applications to Electric Lighting, Transmission of Power, &c., during the academical year 1884-5. A course of practical work in electrical testing and measurement, with especial reference to electrical engineering will also be carried on under his direction in the Wheatstone Laboratory. The lectures will be given once a week—on Mondays at 2 p.m.—and the Laboratory will be open on Wednesdays and Fridays from 1 to 4.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, September 15.—M. Rolland, President, in the chair.—Address delivered at the inauguration of the Fresnel Monument at Broglie, by M. Jamin.—Remarks on algebraic equations, in connection with a communication from M. de Jonquières on the application of geometry to algebra, by M. Léon Lalanne.—Note on the two methods, proposed by Hamilton and Sylvester, for resolving the linear equation in quaternions, by Prof. Sylvester.—On the composition and properties of the light emitted by insects of the Pyrophore genus, by MM. Aubert and Raph. Dubois. Examined under the spectroscope, the spectrum of this light appeared very beautiful, continuous, and destitute alike of very bright and dark bands. It occupied about seventy-five divisions of the micrometer, extending on the red side to the centre of the interval separating the A and B rays of the solar spectrum, and on the side of the blue a little beyond the F ray. When its intensity diminishes, the red and orange disappear altogether, the spectrum being then reduced to the green with a little yellow and red, the green persisting longest. The reverse takes place when the insect begins to glow. Thus the least refrangible rays are the last to be emitted, a result hitherto observed in the spectrum of no other luminous body, except to a limited extent in that of the sulphide of strontium. Examined to ascertain its photo-chemical properties, this light showed a feeble display of the phosphorescence of the sulphide of calcium.—Remarks on a singular case of deformation in the images observed through telescopes, by M. Govi.

Berlin

Physiological Society, August 1.—Dr. A. Auerbach had made experiments to ascertain which of the constituents of flesh exercised the acid, alkali-abstracting effect on the blood witnessed in the reaction of the urine of flesh-eating animals compared with that of the urine of plant-eating animals. He found that the acid phosphoric potash increased the ammoniacal contents of the urine in a manner similar to that of the administration of acids. A dog fed on flesh having been brought into nitrogenous equilibrium, and kept in this state for some days, had a portion of acid phosphoric potash given to it in addition to the meat. The nitrogenous excretion remained the same as before, but the quantity of secreted ammonia had considerably increased, and this increase continued for some days after the dog was put back to the former flesh diet without the salt. The quantity of secreted ammonia corresponded, to the utmost nicety, with the quantity necessary for the conversion of the salts which had been taken, PO_4KHH, into PO_4KNO_4H.—Prof. Kronecker gave a report of a series of experiments conducted during the session now ended in the department of the Physiological Institute under his care. He first recounted the experiments of Mrs. Dr. Boll, who investigated whether asphyxiated fishes could recover animation without a supply of oxygen, and simply by withdrawing the carbonic acid from them. Goldfishes were left in boiled water free of air till the symptoms of asphyxia became distinctly manifest, and then a somewhat diluted caustic lye was added to the water without the admission of air. In every such case the fishes soon recovered their lively movements, and swam about freely in the water. It might therefore be concluded that, with the discharge of the surplus of carbonic acid, the symptoms of asphyxia would also disappear.—Prof. Kronecker then reported on the experiments of Dr. Kranzfeld, which had for their subject the movements of the stomach. In the stomach of each of the animals examined, the cardiac part, the pyloric part, and the middle had to be discriminated. Of these three parts the last was in most cases immovable, while the two other parts displayed lively movements. In the act of swallowing, as observation proved, the stomach took no share. The cardiac and the pyloric parts were excitable in different manners. The pylorus reacted strongly even on slow electric stimulations of moderate intensity such as failed to induce any contraction in the cardiac part. Contraction of the cardiac part followed however more frequent stimulations. The act of vomiting, at least in all the animals examined, was constantly brought about by a swallowing movement. In the discharge of the contents of the stomach, on the other hand, the œsophagus took no part whatever. The motors at work were the abdominal pressure and the movements of the gastric walls, and during the time the vomiting lasted the cardiac orifice was open. The whole mechanism of the act of vomiting was still, however, the subject of investigation. —Dr. Jastreboff has made a particular investigation of the question, important in practice, regarding the effect on the blood-pressure of interference with different parts in the case of operations in the peritoneal cavity. He found that the blood-pressure was raised by all encroachments of this kind, especially that of impinging on the intestine, and, most strongly of all, by a refrigeration of the intestine. In the case of a quick excision of a warm tumour from the peritoneal cavity the blood-pressure rose to quite a rapid rate, and the influence of ether was only able somewhat to abate it.—In continuation of former experiments on the movements of the vagina, Prof. Kronecker has further established that they are not peristaltic movements like those of the intestine, but that the vagina contracts, exactly in the same manner as does the œsophagus,in sections which in definite numbers (mostly three) and in definite series compress themselves from the top downwards. A solution of continuity in the wall of the organ in no respect affected the course of the contraction.—Dr. Ratimoff has studied the effect of chloroform on the heart and the respiration. In order to charge the air with the vapour of chloroform a special apparatus was constructed which allowed an exact registration of the chloroform. Air completely saturated with chloroform contained in every case, whether the process of interfusion took place slowly or rapidly, 30 cubic centimetres of chloroform to 100 litres of air, and invariably caused the death of the rabbits subjected to it, and that through paralysis of the heart. Such a mixture as produced a complete narcosis of the animal, without affecting the heart or the respiration, contained 5·6 or 7 cubic centimetres of chloroform to 100 litres of air, a mixture which was able to maintain the narcosis for hours at a time. In these experiments, however, it appeared that the animals very soon got accustomed to the chloroform, and if, for example, the narcosis was effected at the beginning by a proportion of 5 cubic centimetres of chloroform, the dose had subsequently to be increased to 6 and 6½ cubic centimetres in order to keep up the narcosis.—Dr. Schapiro has investigated the effect of atropine on the frog's heart, and has found it analogous to the effect of heat. The heart became through its application much more accessible to external treatment than in a normal state, and in general its effect may be formulated in the statement that by means of atropine the fissures in the frog's heart become widened. —Mr. Aronsohn had formerly found that 0·73 per cent. solution of ordinary salt was of altogether indifferent and unstimulating effect on the nasal mucous membrane, and offered the best vehicle for the introduction of smelling substances. He now communicated that he had examined other salts, in particular carbonate of soda, sulphate of soda, sulphate of magnesia, &c., with a view to determining in what concentration they affected the nasal mucous membrane with equal indifference as did 0·73 common salt solution. He found that for this purpose much more considerable quantities of these salts were required. In the case of sulphate of soda, for example, four times the quantity that sufficed in the case of common salt was needed to produce the same absence of effect. In such stronger concentrations these solutions might take the place, either in whole or in part, of the kitchen salt solution.—Dr. Heimann reported on a new method for the production of localised pressure on the cerebrum. He placed an animal at the periphery of a round chest made to revolve round its centre, caused it to rotate 300 times a minute, and observed paralytic symptoms which passed away in a short time after the end of the rotation. By experiments he convinced himself that the change in the distribution of the blood in the two halves of the brain produced by the centrifugal force was without influence in this phenomenon, and therefore concluded that it was exclusively the one-sided pressure of the brain against the skull which caused the paralysis. To still further localise this pressure he trepanned the skull at a spot where it was known that the part of the membrane of the cerebrum there situated was the centre for the movements of an extremity, fixed into the opening a cork stopper, which of itself exercised no pressure, and placed the animal in such a posture in the rotating apparatus that the operated side was situated outwardly. In the rotation the spot in question was now pressed against the cork, and so paralysis showed itself in the extremity appertaining to that spot. On the cessation of the revolution the movement of the paralysed part was soon restored. These experiments could be repeated at pleasure without doing any harm to the animal.

VIENNA

Imperial Academy of Sciences, July 17.—K. Laker, on the first microscopic phenomena of coagulation of mammalian blood.—A. Weiss, on a peculiar occurrence of calcium oxalates in the epidermis of the organs of some Acanthaceæ.—On spontaneous movements of vegetable dyeing bodies, by the same.—Preliminary note on a peculiar solved yellow dye in the flowers of some Papaveraceæ, by the same.—L. Boltzmann, on the properties of monocyclic systems and of other systems allied with them.—H. List, on the epithelium of the cloaca of *Scyllium canicula*.—K. Zulkowsky and K. Lepéz, aid to the determination of the halogens of organic bodies. —R. Benedikt and P. Julius, on a new resorcin-blue.—A Nalepa, on the anatomy of Tyroglypha.—O. W. Fischer, contribution to a knowledge of diquinolyles.—On two organic stannum compounds, by the same.—T. Habermann, on some basic salts.—F. Berger, on the action of acetamide in phenylcyanide.—S. Schubert, on the behaviour of the starch-granule if heated.—G. Spitz, on some mixed ethers of resorcin.—K. Natterer, contribution to a knowledge of dichloro-ether.—K. Auer von Welsbach, on rare earths.—Z. H. Skraup and O. W. Fischer, on methyl-phenantroline.—Z. H. Skraup, on a new mode of formation of phenantroline.—L. Szajnocha, contribution to a knowledge of the middle Cretaceous Cephalopod fauna of Elobi Island on the western coast of Africa.—K. Auer von Welsbach, contributions to spectral analysis.—E. von Fleischl, on double refraction of circumpolarising fluids.—E. Steinach, studies on the renal circulation of the blood.

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