THURSDAY, JULY 21, 1881

INHERITANCE

THE tendency in any new character or modification to reappear in the offspring at the same age at which it first appeared in the parents or in one of the parents, is of so much importance in reference to the diversified characters proper to the larvæ of many animals at successive ages, that almost any fresh instance is worth putting on record. I have given many such instances under the term of "inheritance at corresponding ages." No doubt the fact of variations being sometimes inherited at an earlier age than that at which they first appeared—a form of inheritance which has been called by some naturalists "accelerated inheritance"—is almost equally important, for, as was shown in the first edition of the "Origin of Species," all the leading facts of embryology can be explained by these two forms of inheritance, combined with the fact of many variations arising at a somewhat late stage of life. A good instance of inheritance at a corresponding age has lately been communicated to me by Mr. J. P. Bishop of Perry, Wyoming, N.Y., United States:—The hair of a gentleman of American birth (whose name I suppress) began to turn grey when he was twenty years old, and in the course of four or five years became perfectly white. He is now seventy-five years old, and retains plenty of hair on his head. His wife had dark hair, which, at the age of seventy, was only sprinkled with grey. They had four children, all daughters, now grown to womanhood. The eldest daughter began to turn grey at about twenty, and her hair at thirty was perfectly white. A second daughter began to be grey at the same age, and her hair is now almost white. The two remaining daughters have not inherited the peculiarity. Two of the maternal aunts of the father of these children "began to turn grey at an early age, so that by middle life their hair was white." Hence the gentleman in question spoke of the change of colour of his own hair as "a family peculiarity."

Mr. Bishop has also given me a case of inheritance of another kind, namely, of a peculiarity which arose, as it appears, from an injury, accompanied by a diseased state of the part. This latter fact seems to be an important element in all such cases, as I have elsewhere endeavoured to show. A gentleman, when a boy, had the skin of both thumbs badly cracked from exposure to cold, combined with some skin disease. His thumbs swelled greatly, and remained in this state for a long time. When they healed they were misshapen, and the nails ever afterwards were singularly narrow, short, and thick. This gentleman had four children, of whom the eldest, Sarah, had both her thumbs and nails like her father's; the third child, also a daughter, had one thumb similarly deformed. The two other children, a boy and girl, were normal. The daughter, Sarah, had four children, of whom the eldest and the third, both daughters, had their two thumbs deformed; the other two children, a boy and girl, were normal. The great-grandchildren of this gentleman were all normal. Mr. Bishop believes that the old gentleman was correct in attributing the state of his thumbs to cold aided by skin disease, as he positively asserted that his thumbs were not originally misshapen, and there was no record of any previous inherited tendency of the kind in his family. He had six brothers and sisters, who lived to have families, some of them very large families, and in none was there any trace of deformity in their thumbs.

Several more or less closely analogous cases have been recorded; but until within a recent period every one naturally felt much doubt whether the effects of a mutilation or injury were ever really inherited, as accidental coincidences would almost certainly occasionally occur. The subject, however, now wears a totally different aspect, since Dr. Brown-Séquard's famous experiments proving that guinea-pigs of the next generation were affected by operations on certain nerves. Mr. Eugène Dupuy of San Francisco, California, has likewise found, as he informs me, that with these animals "lesions of nerve-trunks are almost invariably transmitted." For instance, "the effects of sections of the cervical sympathetic on the eyes are reproduced in the young, also epilepsy (as described by my eminent friend and master, Dr. Brown-Séquard) when induced by lesions of the sciatic nerve." Mr. Dupuy has communicated to me a still more remarkable case of the transmitted effects on the brain from an injury to a nerve; but I do not feel at liberty to give this case, as Mr. Dupuy intends to pursue his researches, and will, as I hope, publish the results.

July 13 CHARLES DARWIN

VOLCANOES

Volcanoes: what they are, and what they Teach. By John W. Judd, F.R.S., Professor of Geology in the Royal School of Mines. (London: C. Kegan Paul and Co., 1881.)

ONE of the fathers of vulcanology in this country was the late Mr. Poulett Scrope, in whose well-known treatise on Volcanoes, the subject of their cause and effect was for the first time discussed from a thoroughly philosophical standpoint. A great traveller and investigator himself, he strove to imbue younger geologists with his spirit, and when he became too old and infirm to undertake travel and research in distant countries, he directed some chosen disciples to prosecute his favourite lines of thought. Prof. Judd was one of these, and upon him has assuredly fallen the mantle, and a portion of the spirit of his master. His able papers on the study of volcanoes, contributed to the *Geological Magazine*, are well known to every vulcanologist. He has travelled much; he makes good use of both pen and pencil, and he is an accurate observer. We are glad that he has condensed his reading and research into a work, which becomes so widely distributed, both at home and abroad, as the volumes of the International Scientific Series invariably do.

Before entering more minutely into a discussion of the work, we would venture to say that among its few defects, that which strikes us most prominently is an insufficiency of logical sequence and method. The facts are multitudinous; carefully selected, but not carefully arranged. They require to be grouped; to be classified, and each set of facts to be set in apposition to the generalisation which they tend to prove. It is indeed a useful mental discipline for the reader to do this for himself, but unless he starts with some knowledge of the subject, and as the possessor of a thoroughly methodical habit of mind, he can scarcely hope to arrange all the facts as they should be.

After an introductory chapter on the general nature of the inquiry instituted in the succeeding chapters, the author discusses "the nature of volcanic action." To illustrate this he takes the case of the ever-active volcano Stromboli, first examined scientifically by Spallanzani in 1788, and by Mr. Judd in 1874. It is a conical mountain rising 3090 feet above the sea, but the shore slopes to a depth of nearly 600 fathoms, hence the real height of the mountain from the bottom of the ocean exceeds 6000 feet. On the upper side of the crater a spot exists from which it is possible to look down upon the floor of the crater, and here may be seen apertures in which three classes of action take place. From some high-pressure steam is emitted in loud puffs; from others masses of molten lava well out; and in the third kind, a semi-liquid substance may be seen heaving up and down. Sometimes it rises as a kind of scum, swollen by the steam beneath it, and at last a gigantic bubble of molten lava filled with steam appears, and bursts; the imprisoned steam then escapes, carrying with it masses of the bubble high into the air. The author considers that all volcanic phenomena depend on these same conditions: (*a*) cracks or apertures forming communication between the surface and the interior of the earth; (*b*) highly heated matter beneath the surface; and (*c*) imprisoned water.

Animadverting on the common delusion that a volcano is a burning mountain, and that sulphur is the combustible, it is shown that sulphur is the result and not the cause of volcanic action. Common constituents of volcanic action are sulphurous acid and sulphuretted hydrogen, and when these come into contact, according to the author, "water and sulphuric acid are formed and a certain quantity of sulphur is set free." It should be understood however that if the gases are at all dry, as they sometimes are in the Solfataras of Krisuvik and elsewhere, water and sulphur are the sole products of the decomposition, while if moist, sulphur, water, and pentathionic acid are the first result.

If we examine the history of Vesuvius and other volcanic centres which have been known from a remote antiquity, we are led to the following conclusions, as regards the frequency of outbursts:—"(1) A long period of quiescence is generally followed by an eruption which is either of long duration, or of great violence. (2) A long-continued, or very violent eruption is usually followed by a prolonged period of repose. (3) Feeble and short eruptions usually succeed one another at brief intervals. (4) As a general rule, the violence of a great eruption is inversely proportional to its duration."

In the third chapter the author describes the products of volcanic action. In the account of Vulcano he has omitted to mention the very remarkable substance lately analysed by Prof. Cossa of Turin, which contains no fewer than seven non-metals and eight metals, combined in the following forms:—Arsenious sulphide, selenium sulphide, boric acid, ammonium chloride, lithium sulphate, thallium alum, cæsium alum, rubidium alum, and potassium alum. Bunsen's important division of all lavas into "acid lavas" and "basic lavas" is accepted, and the author admits an intermediate lava which contains from 55 to 66 per cent. of silica. He divides lavas further into five great groups: the Rhyolites, Trachytes, Andesites, Phonolites, and Basalts; the first being *acid*, the last *basic*, and the three others intermediate. An interesting account (illustrated by the frontispiece) is given of the microscopic examination of thin sections of rock, and the practicability of tracing by this means the passage from a glassy to a crystalline lava. It is shown that volcanic rocks having precisely the same chemical composition differ considerably in texture according as they are cooled slowly or rapidly. Thus gabbro, basalt, and trachyte are respectively the crystalline, lava, and glassy forms of the same substance. Some interesting details are given of the liquid cavities found in certain crystals, and of their contents.

In the fourth chapter the distribution of materials ejected from volcanic vents is discussed. In the account of "Pele's Hair"—the long threads of lava blown out by high-pressure steam in Hawaii—the reader may be misled. The author speaks of it as "filamentous volcanic glass," and in the passage preceding it (p. 71) he is evidently discussing "glassy lavas" and "pumice," which have been ranged among the acid lavas. But on p. 94 the same lava of Kilauea is spoken of as a "basic lava," although before described as a "molten glass," and presumably acid in character, that is, containing from 66 to 80 per cent. of silica. But basalt is a basic lava, and by rapid cooling it may become a perfect glass, hence we can understand how Pele's Hair may be described as "filamentous glass," without belonging to the class of acid lavas.

In the following chapter an extremely interesting account of the dissection of volcanoes by denudation is given, and the subject is illustrated by some striking examples, among which we may specially mention the plan of the volcano of Mull in the Inner Hebrides. In a past geological period this volcano was probably as large as Etna. The Island of Skye is the basal wreck of another volcano of Tertiary times. In the account of the formation of mineral veins the author has not alluded to Bunsen's surmise that the metallic copper found in the palagonite tuff of the Faroe Islands was reduced by volcanic hydrogen from the chloride.

The sixth chapter treats of the parasitic cones which appear upon the flanks of great volcanoes, and herein we notice one or two errors. Thus on p. 162 we read, "Among the hundreds of parasitic cones which stud the flanks of Etna, there are some which are nearly 800 feet in height." There are however less than a hundred cones worthy of the name, the rest are mere monticules, and of these we believe there are over six hundred. Among the larger cones Monte Minardo is the largest, and it is 750 feet in height, but has undoubtedly been much higher. In Fig. 63, p. 163, the outline of Etna, *as seen from the Val del Bove*, is wrongly described. The picture represents Etna as seen from Bronte, the opposite side of the mountain to the Val del Bove. It is taken from von Waltershausen's "Atlas des Ætna," and appears in Mr. Scrope's book on Volcanoes, in which it is also wrongly described. Occasionally we meet with hasty writing, particularly when the author is firmly convinced of his statement. Such small defects are easily remedied in the second edition. The following is an example of what we mean:

"That volcanoes are thus built up along lines of fissure in the earth's crust, we have the most convincing proofs. Not only have such fissures been seen in actual course of formation at Vesuvius, Etna, and other active volcanoes, but a study of the volcanoes dissected by denudation affords the most convincing evidence of the same fact. The remarkable linear arrangement of volcanoes, which is conspicuous to the most superficial observer, is a very striking evidence of the same fact." A slight looseness of expression is also apparent when the author speaks of carbonic acid as a *poisonous gas*, the fact being that the gas produces suffocation by spasmodically closing the glottis and without entering the lungs at all. On the other hand, carbonic oxide, which has a direct and baneful action on the organism, may truly be described as a poisonous gas.

In the account of Geysers the author, after stating that many attempts have been made to explain the mechanism by which the intermittent action of geysers is produced, remarks that probably no "such explanation will cover all the varied phenomena exhibited by them." Herein he does not even allude to Bunsen's classical experiments on the action of geysers, which are generally accepted as furnishing conclusive proofs of the mechanics of these intermittent springs.

A highly-instructive chapter discusses the number and distribution of volcanoes. In the second edition the map inserted at the beginning of Mr. Scrope's book might with advantage be introduced.

Concluding chapters discuss the information furnished by volcanoes concerning the interior of the earth, and the attempts made to explain the causes of volcanic action. In regard to this latter matter we are left as much in the dark as ever, and authors usually content themselves with stating the various hypotheses which have been proposed, leaving the reader to select that which he considers the most rational.

Prof. Judd's work is very instructive, and it will excite intense interest in the minds of many readers. Laid down upon the lines of Mr. Scrope's book, it is less methodical, less philosophical, and to most people more readable. A few things seem to us to be wanting, but probably the author has good reasons for their omission. Particularly we notice the absence of references to the labours of such men as Bunsen, von Waltershausen, Johnstrup, von Lasaulx, Steenstrup, Elie de Beaumont, and Tacchini. Iceland, the most marvellous country in the world from the volcanic point of view, is scarcely alluded to. And, as we said above, it seems to us that we require some *νοῦς* to arrange and put in order the countless *ὁμοιομέρειαι* that are scattered throughout the pages. But even without this we cannot read the book attentively without feeling that we have acquired a great mass of information concerning phenomena which have occupied the attention of wise men from the earliest times.

G. F. RODWELL

THE FIGURE OF THE EARTH

The Figure of the Earth: an Introduction to Geodesy. By Mansfield Merriman. (New York, 1881.)

THE author of this volume has already made his name known to us as the writer of an excellent treatise on the Method of Least Squares. The book before us presents to the reader, who is supposed to have some little knowledge of Algebra and Geometry, an explanatory and historical sketch of the labours of geodesists from the earliest days. We read in Chapter I. that Anaximander—a speculator in Geometry, Astronomy, and other sciences—concluded, from some reasons best known to himself, that the earth was a cylinder whose height is three times its diameter. There must have been some good reason for this idea, for we are told that Anaxagoras held the same. And it is scarcely to be wondered at that Plato originated some views of his own in the matter.

Passing to comparatively modern times we have a detailed account of the measurement of a degree (in 1766–68) by Mason and Dixon along the boundary line between the states of Maryland and Delaware. This measure gave 3947 miles as the radius of our supposed sphere.

Then the Franco-Peruvian expedition—*circa* 1736—of the Academicians MM. Bouguer and Lacondamine is briefly referred to (and here there is a misprint in the length of the base-line at Cotchesqui, which was 6274 toises in length), their labours giving 3936 miles as the radius. Henceforth the earth, abandoning its claims to sphericity, and not escaping a temporary imputation of being egg-shaped, settles down into an oblate spheroid—the figure generated by the revolution of an ellipse round its lesser axis.

Chapter II. treats of the method of determining the excentricity of this spheroid. As one measured arc will determine the radius of the spherical earth, so two measured arcs determine the radii of the spheroidal earth, that is, if the two arcs differ considerably in latitude. The actual excentricity is then calculated from the arc measured in Peru and that measured in Lapland. Then, further, taking the arc measured in France and combining these three in pairs, three quite different values of the excentricity are obtained. Here enters a discord not yet resolved; and in fact all modern measurements show that the earth is not a true spheroid, for, combining the arcs in pairs, all kinds of values of the excentricity present themselves. Then we fall back on the method of least squares, and grouping all the measurements into a unique calculation, we get a unique value of the excentricity, which may, with some show of reason, be called the most probable value. A specimen of this mode of calculation applied to pendulum observations is given at page 52; and it may be noted in passing that the calculation would have been made both neater and simpler by writing $S + 39$ instead of S. By inadvertence it is stated at page 54 that pendulum observations give 1–288·5 as the earth's ellipticity, and again at page 64, 1–289 is given as the result of the same observations. But these are the ellipticities that were obtained previous to the very extensive pendulum work recently completed by General Walker in India. When these modern observations are taken into account the 1–289 is changed to 1–292 or 1–293.

The earth then being no true spheroid, an attempt, described in Chapter III., is made to ascertain whether it is an ellipsoid with three unequal axes. Here but little better success is met with, and failing to establish for itself any fair name, the earth, like other pretenders, takes shelter under hard words, and in the concluding chapter of the book calls itself a geoid. Here we are safe and beyond controversy, for your geoid makes no pretensions except to irregularity.

The surface of the geoid is in fact at every point perpendicular to the direction of gravity there. Thus the surface of the (unagitated) sea is a geoid, the surface of all lakes are portions of geoidal surfaces, nearly but not exactly parallel to that of the sea. That particular geoidal surface which represents the figure of the earth is the sea surface, which indeed is an old enough idea with a new name.

The work may be characterised as a fairly successful attempt to combine the advantages of a scientific and a popular treatment of its subject. It does not claim originality, and the mechanical theory of the earth's figure is not touched on.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Special Solar Heat-Radiations and their Earth-felt Effects

I REGRET if, by the words "lagging behind" in my paper to NATURE, vol. xxiv. p. 150, I have inadvertently misrepresented the views of Prof. Piazzi Smyth. Had his paper been only recently published, I might have been able to plead ignorance of its contents, but it is one which was published in 1869, and which I have read several times in the belief that it contains not only the first, but likewise the most complete contribution to this branch of knowledge.

Having made this confession, let me now in a very words endeavour to render clear that which I intended to say.

The hypothesis advocated in the lectures to which Prof. Smyth alludes was that which represents the sun as most powerful when it has most spots on its surface. Nevertheless if we take the observations of Prof. Smyth, of Mr. Stone, and of Dr. Köppen, and bring them together, we are led to think that perhaps on the whole we have highest temperatures about those times when there are fewest spots on the sun's surface. I then endeavoured to show that such an experience was nevertheless not inconsistent with the hypothesis of increased solar heat during times of most sun-spots.

Again, if we take rainfall, while we find that perhaps on the whole there is most rain during times of maximum sun-spots, yet there are certain stations which form an exception to this rule. Nor is this to be wondered at if we reflect that the direction, as well as the intensity, of the earth's convection currents must be affected by solar variability, and bear in mind that local causes have a very powerful influence upon rainfall. Now this last remark applies to temperature as well.. I should therefore be prepared to hold, *simply as a working hypothesis*—

1. That, on the whole, the temperature on land may be less at times of maximum than at times of minimum sun-spots.

2. That, on the whole, the rainfall on land may be greater at times of maximum than at times of minimum sun-spots.

3. That while a period of temperature and one of rainfall coinciding with the sun-spot period will probably be found at most stations, nevertheless in individual localities the turning-points of these periods may vary considerably from the rule laid down in 1 and 2.

4. That the above order of phenomena is not inconsistent with the hypothesis that the sun is most powerful when there are most spots on its surface.

In conclusion permit me cordially to assent to the remarks of Prof. Smyth about the possibility of rapid outbreaks of solar heat being responded to by the earth; it may be only a few hours afterwards. His Madeira observations are of great interest to those who, like ourselves, believe that the bond between the sun and the earth is more intimate and sympathetic and less formal in its nature than that which the older generations of astronomers have been accustomed to imagine.

14, Queen's Road, Bayswater BALFOUR STEWART

How to Prevent Drowning

I OBSERVE several letters in NATURE, vol. xxiv. pp. 101 and 126, on floating as a means of preventing drowning, but I do not think the last word is yet said on this subject. I fully agree with Dr. Dudgeon that no rules for preventing drowning are of any practical value, and also with Mr. Hill and Dr. Dudgeon that those who can float are the rare exceptions. According to my observation not one in ten, in fact I might say hardly one in 100 even, of good swimmers can float in fresh water in any useful fashion, *i.e.*, lying motionless on the water and breathing easily. The obvious reason is that the human body in the natural condition, *i.e.*, with the lungs half inflated, is specifically heavier than water. Many persons say they can float, but in most cases they either inflate the lungs and hold the breath, or else they make slight movements of the hands.

But Dr. Dudgeon is wrong in supposing that the exceptions are all fat men. I am myself a case in point. I am slender almost to meagreness, and yet I float easily. From boyhood I have been fond of all athletic sports, and especially I am a practised and expert swimmer. I swim almost as easily as I walk. I float even in fresh water with the utmost ease, and for any length of time, breathing meanwhile naturally. While floating, the whole face, a large area on the chest, a small spot on the knees, and the tips of the toes are above the surface. Breathing causes the body to rise and fall gently, so that the exposed areas of the face and chest increase and diminish alternately.

It is evident therefore that the cases of persons who can really float are of two kinds, viz., (1) Those who are very fat, and (2) slender persons with very small bones and proportionately large lungs. This latter is my case. I never knew a heavy, muscular, large-boned man without excess of fat who could float. Such men make powerful swimmers, but are less easy and graceful in the water than those who are slenderer.

Berkeley, California, June 27 JOSEPH LE CONTE

Optical Phenomenon

I INCLOSE copies of photographs from two negatives (as you may see by looking at the points stereoscopically) of the Cyclopean gallery at Tiryns, for the sake of calling attention to the optical phenomenon shown in it. The gallery is very dark, the only light entering it by the narrow entrance and crevices between the rocks. At the extreme end of the gallery is an opening to the sky large enough to put one's hand through. In the photograph this is shown as a nucleus by a black speck surrounded by bright light, around which appears a dark circle, which again is encircled by a halo as perfectly rendered as one can see that around the moon at times. The dark nucleus is larger in the negative which had the longest exposure (the irregular lights around are only the light falling on the stones from side openings not visible). There was no such phenomenon recognisable to the naked eye.

The exposures were 25 and 15 min. with the full opening of the Ross "portable" lens and a gelatine plate.

Athens, July 3 W. J. STILLMAN

[The photographs quite bear out Mr. Stillman's statements.—ED.]

Implements at Acton

IN reply to the letter of Mr. Worthington G. Smith (NATURE, vol. xxiv. p. 141), the Palæolithic implements at Acton I found in a gravel pit on the hill west of the North London Railway, and from spread gravel which was local. Those I obtained at Hammersmith occurred in gravel raised on a piece of ground (Mr. Butt's) south of Great Church Lane, where building is going on. They consisted of a hollow scraper, drill, &c., which I readily found; but the implements here seem ruder than at Acton, and less easy of detection. I also found implements in gravel raised from the foundations of the neighbouring houses, which had been spread on some newly-made roads south of Shepherd's Bush, between the Uxbridge Road and Addison Road Stations. I see no reason for supposing that the implements here or at Hammersmith occur under different conditions from those at Acton.

I examined carefully, some weeks ago, some extensive heaps of sand and gravel raised on the premises of the Water-works Company on the right across the Hammersmith Suspension-bridge, but found no worked flints. The gravel here may be of more recent deposition.

With regard to the Neolithic implements of Acton, I am interested to hear that Mr. Worthington Smith is familiar with them, and that there are specimens in the Pitt-Rivers Collection. My letter nevertheless will have done good in making their occurrence more generally known.

As regards the quartzite pebble, if more are found on the fields about Acton it will tend to show that they have served the same purpose as those in South-East Devon, and that they have been brought from a region where specimens adapted for missiles would be found in abundance, viz. the south-west coast, as gravel sections and gravel pits were not accessible in Neolithic times, nor would they have proved adequate arsenals. But if the pebble I found at Acton were accidentally derived from the Middlesex gravel (which contains a considerable quantity of Midland Bunter material), it is remarkable that a selection should have been made so well calculated to deceive a Devonshire neolithologist.

July 19 SPENCER GEO. PERCEVAL

Lightning

ABOUT 10 a.m. of the 6th instant two of the labourers on this farm were sitting on the ground (with their backs against a clover haystack and their faces towards the north, having in front of them and on their left a wood) engaged in eating their lunch. It had been raining and thundering for about half an hour, but not heavily, until suddenly—in the words of one of the men—"a flash of lightning came right at us as if it were shot out of a gun." This man had his knife up to his mouth at the time in the act of eating, and he describes his sensation as a feeling of nausea in his throat and chest, and also that both he and his companion felt an actual push against their shoulders, which swayed and shook them to a considerable extent from the direction of the flash. The other man was blinded for about five minutes, and they were both much dazed for some time. Also they both describe having heard a sharp whiz somewhat resembling the quick escape of steam from an escape valve on an engine. For two days after they both suffered from severe headache. A. HALL, JUN.

Filstone Hall, Shoreham, Kent, July 11

THE COMET

IN a paper read to the Paris Academy on the 11th inst., giving further observations on comet *b* 1881, M. Wolf says:—

"The analysis of the light of the comet furnishes data as to the constitution of that body, which it is important to consider before starting any hypothesis as to its nature and mode of evolution.

"I have examined the spectrum of the comet, both with a highly dispersive spectroscope mounted on the Foucault telescope of 0·40 m. aperture, and with a smaller instrument, mounted on the telescope of 1·20m., giving therefore a very large quantity of light. This spectrum is triple: one sees (1) a continuous spectrum, broad, but very pale, visible in all the regions of the comet; (2) a continuous spectrum nearly linear, and very bright, given by the nucleus; (3) the spectrum of three bands, yellow, green, and blue, characteristic of the light of all comets examined hitherto. I have never been able to see the violet band.

"The continuous spectrum of the nucleus indicates the existence of solid or liquid matter, luminous of itself or by reflection. I have suspected in the strip some dark interruptions, especially in the region near D, without being able to determine their position. The presence of these dark lines, demonstrated by Dr. Huggins' photographs, denotes a reflected light, which can be no other than that of the sun.

"The nebulosity which forms the head of the comet gives, besides the continuous pale spectrum, the bright bands of an incandescent compound gas. The researches of M. Hasselberg tend to assimilate these bands to those of a carburet of hydrogen, probably acetylene. Besides these bands one sees throughout the strip formed by the light of the nucleus other protuberances very short, and paler, which seem to indicate, in the hotter and more luminous parts of the comet, an incandescent atmosphere of more complex constitution.

"When the slit of the spectroscope is passed over the comet, starting from the head, one finds the three bands all round the nucleus, at nearly the same distance from all the sides. They disappear in the tail properly so-called, the very pale spectrum of which seems to be continuous. Thus only the nebulosity surrounding the nucleus contains incandescent gases. The light of the tail comes to us from a pulverulent matter, luminous, or simply illuminated. Such are the data of spectroscopy.

"The polariscopic examination of the comet's light completes these first results. I used, as polariscope, a quartz plate perpendicular to the axis, giving the sensible tint, and a double-refracting prism, placed between a collimator and an observing telescope, in place of the prism of a direct-vision spectroscope. The two images of the nucleus and the nebulosity surrounding it are projected, well separate, on the common part of the field formed by the background of the sky; this is the process indicated long ago by M. Prazmowski for eliminating atmospheric polarisation. Under these conditions the nucleus and the nebulosity appear both distinctly polarised in the median plane of the tail, consequently in the plane passing through the sun. Here then, at least in all parts of the nebulosity round the nucleus, we have reflected light coming from the sun, and a non-gaseous matter possessed of reflecting power. I have had this important result verified by my assistant, M. Guénaire, and by several students in the Observatory.

"This process, so sensitive, evidently cannot serve for the tail, which occupies the whole field of vision, and does not moreover present very distinct limits. I have vainly tried other polariscopes—Savart's, for example. It would be very difficult besides to separate here the real polarisation of the tail from that of the atmosphere.

"In proportion as the light of the comet is diminished, the spectrum of the nucleus becomes paler; its colours, well pronounced on the earlier days, are no longer seen except on the side of the red; the bright bands retain their brightness. The green band is always distinctly limited in the less refrangible part. It will be interesting to know whether the comet, reduced to telescopic brightness, will at the same time have its light reduced to that of an atmosphere purely gaseous.

"On June 29, at 5h. 49m. sidereal time, during my polariscopic observations, a small star was found in the nebulosity, at a very short distance from the nucleus. Its image had not undergone any change, either of brightness or of form."

At the same *séance* M. Thollon communicated a note of spectroscopic observations of the comet as follows:—

"These observations were made with a direct-vision spectroscope which MM. Henry of the Observatory were good enough to lend me. The dispersion is that of an ordinary prism. A micrometer eye-piece, with point, giving 1-200th of a millimetre, enables one to make measurements of very high precision.

"In the night of June 24 I made my first observations and measurements. The nucleus presented then a very brilliant continuous spectrum, on which no trace of bands could be distinguished. On the violet side it extended beyond the line G. The parts next the nucleus likewise gave a continuous spectrum, on which the bands were still invisible; they only appeared a little further on and faintly. In the continuous spectrum I have thought I perceived several times a very complicated system of dark lines, and occasionally I believed I saw in the spectrum bright parts having the aspect of short lines, not occupying the whole width of the spectrum. This was perhaps merely a result of fatigue of the eyes; these phenomena were only produced during the first two nights.

"It appeared to me important to follow the modifications the spectrum might undergo as the comet went away from the sun. These modifications were produced with perfect distinctness. In the spectrum of the nucleus the violet radiations were extinguished first. About June 30 the most refrangible part, commencing with the green band ($\lambda = 516$), had sensibly lost its brightness and became invisible in the region G, while the yellow and red appeared to me as bright as on the first day. The bands, masked at first by the brightness of the continuous spectrum, became each day more visible in the neighbourhood of the nucleus, and during the night of July 1 they were perfectly distinguished on the nucleus itself.

"The measurements successively made of the bands of the comet and of those of the alcohol flame led me to conclude the identity of the two spectra. The green band however, the most brilliant, seemed a little more refracted in the comet than in the flame. To submit this matter to a decisive test, a total reflection-prism was adjusted on the slit so as to cover half of it. On placing the two spectra together I observed that they were strikingly similar when they had the same brightness, but that the green band appeared indeed more refracted in the comet when the spectrum of the flame was more brilliant. The comparison made directly between the two spectra, and the perfect coincidence of the bands, dispense with the necessity of giving numbers furnished by my micrometric measurements. They would not add anything to the certainty of the result.

"As to the violet band, it has not been possible for me to see it in a certain manner, even using a very small dispersion and a very small ocular enlargement. There is not in this fact anything surprising, if we take account of atmospheric absorption and of variations of brightness undergone by the violet band, when the experimental conditions are varied. We know that in the ordinary flame of alcohol it is very brilliant; but if this flame be cooled by means of several folds of metallic sheeting, it becomes very weak and tends to disappear, while the other bands sensibly retain their habitual aspect.

"Continuing my observations till the present, I have found the continuous spectrum of the nucleus diminish progressively in brightness and extent, especially on the violet side. At present it has the aspect of a thin luminous thread, hardly passing beyond the line F. The bands, on the other hand, seem to have retained their intensity in the head of the comet. In the tail, and to a distance from the nucleus equal to twice or thrice the diameter of the head, they are still seen, but very faintly. Further on one sees only a continuous spectrum due perhaps to the light of the moon diffused by the haze, pretty thick during the last nights of observation.

"It seems to result from this that the cometary mass is formed in part of an incandescent gas, characterised by the spectrum of bands, and in part of solid or liquid matter, likewise incandescent, but in a state of extreme division, emitting a white light which belongs to it, and capable of reflecting in a certain proportion the light it receives from the sun. All the spectroscopic observations hitherto made on comets indicate the existence of carbon in the gases producing the band-spectrum. Dr. Huggins has given this conclusion a striking demonstration by showing, with photography, the existence of two bands of carbon in the ultra-violet spectrum of the comet.

"I have the honour to submit to the Academy three drawings representing (1) the spectrum of the alcohol flame, (2) the spectrum of the comet during the night of June 24, and (3) the same spectrum on July 1."

WIDTH OF MR. RUTHERFURD'S RULINGS

BY the direction of C. P. Patterson, the Superintendent of the U.S. Coast and Geodetic Survey, I have long been engaged in the precise measurement of a wave-length of light, in order to obtain a check upon the secular molecular changes of metallic bars used as standards of length. In advance of the publication of this work it may be useful to say I have found that the closest-ruled diffraction-plates by Mr. Lewis Rutherfurd have a mean width of ruling which varies in different specimens from 68078 to 68082 lines to the decimetre, at 70° F. There is a solar spectral line, well suited for precise observation, whose minimum deviation with one of Mr. Rutherfurd's plates in the spectrum of the second order with the closest ruled plates is 45° 01′ 56″ at 70° F. I would propose that this line be adopted as a standard of reference by such observers of wave-lengths as desire to escape the arduous operation of measuring the mean width of their rulings; for by means of the measures which are shortly to be published it will be possible to deduce from the minimum deviation of this line produced by any given gitter, the mean width of that gitter, and consequently the wave-length of any other line whose deviation has been observed with it. The accuracy of this method will greatly exceed that of assuming Ångström's measures to be correct. The wave-length of the line in question (still subject to some corrections which may be considerable) is 5624825. Ångström gives 562336.

C. S. PEIRCE

CITY AND GUILDS OF LONDON INSTITUTE

IT would seem as if at last, after long years of waiting, there were some hope that the views which for the last quarter of a century have been so persistently advocated touching technical education, were about to bring forth more fruit in London.

In season and out of season, since the note was first sounded by the late Prince Consort, one far-seeing advocate after another, and among these we must specially name Mr. Samuelson, Mr. Mundella, and Sir Henry Cole, have cried in the wilderness touching the need of more scientific instruction. At last it does seem as if there is an awakening, as if a part of the idea was realised in the Institute, the foundation-stone of which was laid at South Kensington on Monday by the Prince of Wales. No doubt in the building which has been begun a national school of science, theoretical and applied, worthy of a country like ours, may grow up. Mr. Mundella will rejoice that at last he has an opportunity of carrying out with something like adequacy the views on education of which he has been so long a strenuous advocate. We hope next week to give a detailed description and illustration of the new building; and meanwhile will content ourselves with briefly referring to what took place on Monday.

The company present to receive the Prince of Wales was large and distinguished, including many eminent men of science. The Lord Chancellor, as Chairman of the Institute, addressed the Prince, expressing the gratification of the Council that His Royal Highness had consented to become president. The Lord Chancellor then traced the growth of the Institute and the efforts of the City Guilds to improve the technical education of the country.

"Since July of last year," the Lord Chancellor said, "the date of the incorporation of the Institute, its work has satisfactorily increased, and the Council have a lively and grateful recollection of the assistance and encouragement afforded to them by His Royal Highness, Prince Leopold, Duke of Albany, who in May last laid the foundation-stone of the Finsbury Technical College, a college that has been established by this Institute, and which, when erected, will be the first building in the metropolis exclusively devoted to technical teaching. Pending the completion of the Finsbury College, instruction is being given to a large and increasing number of artisan students in some of the applications of chemical science to manufactures and industrial operations, and also in that new and widely opening field of labour and invention—the application of electrical science to the transmission and conservation of energy. Instruction will also be provided in that college, when finished, for those who are engaged in various handicraft trades, and it is hoped that this kind of teaching, which is gradually taking the place of apprenticeship in France, Germany, and Sweden, will help in this country to supplement, without supplanting, workshop training. The Institute is also endeavouring to advance technical education in a large number of towns in the United Kingdom by holding annual examinations in technology, and by encouraging, in connection with these examinations, the formation of evening classes for artisans, by assisting in the payment of teachers of technical subjects. During the early part of the present year more than eighty such classes were in operation, and it is satisfactory to know that the number of candidates recently examined by the Institute in different branches of technology was 1563 as compared with 816 in the previous year. But it is to the Central Institution," the Lord Chancellor went on to say, "the first supporting pillar of which your Royal Highness has graciously consented to set this day, that the Council look to crown their endeavours and give unanimity to all their efforts. In this college, from which the entire work of the Institute will be directed, instruction of a higher and more advanced character will be given, adapted to the wants of those who will be engaged in professional or commercial pursuits, in which a knowledge of some branch of mechanics, physics, or chemistry in its practical application will be found not only serviceable but almost indispensable. The building when completed will be supplied with laboratories, in which the most delicate operations can be carried on, with workshops in which the various branches of mechanical and electrical engineering will be taught, with studios in which applied art may be practised, and with a lecture-hall, theatres, and class-rooms in which the principles of science will be explained. Here, it is anticipated, will receive their professional training the sons of manufacturers, many of whom have hitherto been compelled to pursue their studies abroad—in Germany, in Switzerland, in France, or in America, in all which countries, for some time past, technical colleges, such as this Central Institution is intended to be, have already flourished. Here it is expected that artisans who have shown merit and have won distinction at the branch or provincial colleges will complete the training which may qualify them to act as managers and superintendents of works. Some of these, it is hoped, will obtain their education in this college by means of scholarships to be established by the Institute itself, possibly by provincial colleges, trade societies, or other public bodies, or by private individuals who may be interested in the promotion of technical education. And here it is anticipated will be trained that body of technical teachers, of whom there is in England at the present moment so great a need, who will carry with them from this college into the manufacturing centres, to be there imparted to other students, a knowledge of the theory and the practice of various crafts and industries. This institution will not be established as a rival to any other existing seat of learning; least of all to the excellent schools situated in this neighbourhood, which for some years past have been the means of offering to hundreds of young men and women a knowledge of the principles of science and art. The aim of this institution will be to supplement the teaching of those schools by giving instruction in the practical application of science and art to the trades and industries of the country, and by cultivating and endeavouring to stimulate inventive genius. It is therefore hoped and anticipated that the sister institutions, representing pure and applied science, will work in harmony with each other, forming an alliance, the effect of which will be to raise the intellectual *status* and to improve the technical knowledge and practical skill of the working classes of this country, and so to increase its industrial prosperity. It gives me great pleasure to be enabled to add that it has seemed fit to Her Majesty to recognise on this occasion the eminent services of Mr. Bramwell, the indefatigable chairman of the executive committee of the institution, by signifying Her Majesty's gracious intention of conferring upon that gentleman the honour of knighthood. It is anticipated that the cost of this building, when fully equipped with the apparatus and appliances needful for technical instruction, will not fall far short of 75,000*l*. Of this sum 31,000*l*. has been alread subscribed by the worshipful companies of Fishmongers, Goldsmiths, Clothworkers, and Cordwainers; the grant of the Drapers' Company having been appropriated to the Finsbury College; and it is expected that about 24,000*l*. will be saved from the annual income of the Institute during the building of this college. The Council therefore, after paying the amount which is due, will have at their disposal only an estimated sum of about 55,000*l*., and they look to the liberality of the Livery Companies, both of those who have and of those who have not as yet subscribed to the funds of the Institute, to make good the balance of 20,000*l*., so that the building of this college may be completed at once and as a whole, in strict accordance with the plans."

The Prince of Wales in reply made some forcible and sensible remarks on the necessity to this country of improved technical education—education in things as contrasted with words—if we are to keep our place among the other industrial nations. "Other nations," the Prince said, "which did not possess in such abundance as Great Britain coal, the source of power, and iron, the essence of strength, compensated for the want of raw material by the technical education of their industrial classes, and this country has therefore seen manufactures springing up everywhere guided by the trained intelligence thus created. Both in Europe and in America technical colleges for teaching, not the practice, but the principles of science and art involved in particular industries, had been organised in all the leading centres of industry. England is now thoroughly aware of the necessity for supplementing her educational institutions by colleges of a like nature." The new building, the Prince remarked, will be of considerable benefit to the whole kingdom, not only as an example of the Institute devoting itself to technical training, but as a focus likewise for uniting the different technical schools in the metropolis already in existence, and as a central establishment also to which promising students from the provinces may, by the aid of scholarships, be brought to benefit by the superior instruction which London can command. The Prince reminded his audience that the realisation of the idea of such a college was one of the most cherished objects which his father had in view. "It is to me," the Prince stated, "a peculiar pleasure that the Commissioners of the Exhibition, of which I am the president, have been able to contribute to your present important undertaking, by giving to you the ground upon which the present college is to be erected with a sufficient reserve of land to insure its future development. By consenting at your request to become the president of this institute I hope it may be in my power to benefit the good work, and that our joint exertions, aided, I trust, by the continued liberality of the City and Guilds of London, may prove to be an example to the rest of the country to train the intelligence of industrial communities, so that, with the increasing competition of the world, England may retain her proud pre-eminence as a manufacturing nation." Among the articles deposited in the stone were copies of the *Times*, *Nature*, and the *City Press*.]

NOTES

THE Graham medal, instituted in connection with the Philosophical Society of Glasgow (Chemical Section), for the encouragement of chemical research, and open to competition to all chemists, has, on the recommendation of Prof. Williamson, F.R.S., the adjudicator in the competition, been awarded to Mr. James Mactear, F.C.S., F.I C., for a paper entitled "Some Researches on the Reactions involved in the Leblanc Process of Alkali Manufacture."

THE fifty-fourth meeting of the German Association of Naturalists and Physicians will be held at Salzburg on September 18 24 next. From the list of addresses we note the following:—Dr. von Pettenkofer (Munich), on the soil and its connection with the health of man; Herr Meynert (Vienna), on the laws which govern human thoughts and actions; Dr. von Oppolzer (Vienna), on the question: Is Newton's law of gravitation sufficient for the explanation of the motion of heavenly bodies, and are there reasons to designate it only as approximately true? Herr Mach (Prague), on natural history teaching. All these addresses (besides one by Herr Weismann (Freiburg-im-Bresgau), the subject of which is not yet fixed) will be delivered at the general meetings. For the entertainment of visitors sufficient preparations will be made; the programme enumerates social gatherings, concerts, and excursions into the charming neighbourhood of Salzburg.

THE German Society for Anthropology, Ethnology, and Prehistoric Research will meet this year at Ratisbon on August 8-10 next. The programme of the meeting is a very varied one. In the first place the members will visit the curiosities and collections of the ancient city itself and the numerous Roman antiquities in the neighbourhood. At the Roman necropolis near Kumpfmühl some excavations will be made. Addresses will be delivered on the Roman period in Germany, on the period of serial tombs, on the pre-Roman metal age, on the stone period, and on anthropological questions generally.

ON Saturday the Prince of Wales opened, at South Kensington, the International Medical and Sanitary Exhibition which is being held in connection with the forthcoming Medical Congress. Up to the present nearly 2000 members of the medical profession have signified their intention of attending the Congress.

AT the Annual General Meeting of the Society of Arts medals were awarded as follows for papers read at the meetings of the Society:—Prof. A. Graham Bell, E. P. Edwards (of the Trinity House), Mr. Alex. Siemens, Sir Bartle Frere, Mr. J. Y. Buchanan, Prof. Perry, Sir Richard Temple, and Mr. J. M. Maclean.

AMONG recent valuable additions of models of ships to the collection now being exhibited in the galleries south of the Royal Horticultural Gardens is a whole model of the *Livadia*, showing in miniature all the details of that noted yacht. It is lent by the builders, Messrs. John Elder and Co. The London and Glasgow Shipbuilding and Engineering Company have lent half-block models of three of their steamships, and by an ingenious use of mirrors in mounting these the whole of each vessel is represented, and fore and aft views can be conveniently studied. There are many other admirable models.

THE geological distribution of endemic goître in England has been made the subject of a recent paper by Prof. Lebour of Newcastle. He shows that there is on the whole a striking sameness in the distribution in this country and in France, where Dr. de St. Lager of Lyons has fully investigated the facts. One important point only he considers to be established as common to those rocks on which goître does not occur—the absence of limestone together with that of metallic impurities. In both countries the rocks which support most goître are such as are both calcareous and metalliferous. But there are plenty of facts to show that metalliferous impurities alone cannot be credited with the origin of the disease, else the Devonian and the granite would surely not be free from it. Neither will the absence of limestone alone be sufficient to check the growth of the disease, else the lignitiferous beds of France and the ferruginous sands of the Weald would not support it. (Dr. de St. Lager's conclusion is that endemic goître coincides with metalliferous deposits, iron pyrites being in the first rank.)

THE Handbook of the Vertebrate Fauna of the County of York, by W. E. Clarke and W. D. Roebuck, the secretaries of the Yorkshire Naturalists' Union, is expected to appear about the beginning of August. The work will show what species are, or have been, within historical periods, found in Yorkshire. The authors are enabled to enumerate, as such, 508 species out of a total British list of 756, a fauna superior in numerical extent to that of any other county in the British Isles. The list includes 46 mammals, more than 300 birds (doubtful species being excluded), 12 reptiles and amphibians, and upwards of 150 fishes. For comparison, the British species *not* found in Yorkshire are also enumerated. Application should be made to the above-named gentlemen, 9, Commercial Buildings, Park Row, Leeds.

THE Marine excursion of the Birmingham Natural History and Microscopical Society to Oban this year, which extended from July 1 to July 12, proved a great success, and fully answered the expectations of its promoters. Thirty-two Members joined the excursion, including Dr. Thomas Wright, F.R.S., the President of the Midland Union of Natural History Societies, and Mr. E. D. Hamel, Ex-President of the Tamworth Natural History Society. There were also several ladies. A little steamer—the *Curlew*—of about twenty-five tons burthen, was chartered for a week. Dredging operations were carried on daily in the Bay of Oban and the neighbourhood in depths varying from fifteen to fifty fathoms, under the superintendence of Mr. Edmund Tonks, B.C.S., and Mr. W. R. Hughes, F.L.S. A most interesting and beautiful collection of animals was taken. The specimens included fine examples of the Alcyonarian zoophytes. The Echinoderms embraced many genera from *Antedon* (*Comatula*) through the group to *Holothuria*. The Mollusca were not very numerous, but they included several rare forms. A few interesting fishes were taken, including the Lump-Sucker. The specimens will be examined by specialists and reported to the Society in due course. Those Members who did not engage in the dredgings had good opportunities of botanising and geologising, the indefatigable honorary secretary, Mr. Morley, having arranged a series of excursions to the principal places of interest in the district. On Sunday evenings July 3 and July 10, Dr. Wright also gave by request addresses "On the Basaltic Formations of Staffa and Iona," and "On Glaciation," which afforded great gratification to the Members. In the evenings demonstrations were given by the microscope and otherwise on the more interesting forms of life taken, by Prof. Bridge, Mr. W. P. Marshall, Mr. W. R. Hughes, and Mr. G. W. Tait. By the courtesy of Mr. R. H. Scott, of the Meteorological Office, telegrams were received daily, giving the weather forecasts for the morrow, which enabled the members to make their arrangements. At the termination of the excursion votes of thanks were accorded to the leaders of the party, who rendered assistance in various ways, and a resolution was passed selecting the Channel Islands as the place for the next marine excursion.

THE German Government has been requested by many eminent hydrologists to establish a hydrological "Reichs-Centralstelle." They consider hydrological researches extending over the whole Empire necessary for the general welfare with regard to the utilisation of water and for the general protection of arable lands against floods and inundations. As these researches would necessarily often be combined with meteorological observations, it is proposed to connect the Hydrological Office with the Meteorological Central Office. The work would have to be done principally by hydrologists and meteorologists, but the staff would have to comprise geologists, agriculturists, and forest-rangers.

THE news that in the Pastorat Moor of Dejbjerg (district of Rinkjöbing, Jütland) a carriage of the fourth or fifth century has been discovered, causes great sensation in archæological circles. At the beginning of this year the Museum of Northern Antiquities of Copenhagen received several bronzes which had been found in the moor in question, which unquestionably had originally been carriage ornaments. Perfectly similar bronzes had been found a few years ago at Broholm (Fünen) in a tomb, and had been explained as ornaments of a wooden carriage which had been burned with the dead. The discovery in the Dejbjerg Moor now confirms this view. Dr. H. Petersen, who also conducts the excavations at Broholm, was intrusted with the investigation of the Dejbjerg Moor, and his researches show that the fragments now found belonged to a state carriage with neatly turned spars and fine bronze ornaments on the wheels and sides. Apart from the carriage fragments only a few clay vessels were found. They all date from the migration period.

THE Archæological Society at Athens has purchased the land at Eleusis necessary in order to excavate the temple of Ceres. News from the director of the excavations at Epidauros state that the theatre excavated in the forest of Asklepios is the second largest of Ancient Greece and a masterpiece of the architect Polykleitos. Even the headless statue found there, which is supposed to represent Hygieia, is believed to be a work of Polykleitos.

THE Museum of Antiquities at Sparta is reported to have been broken open and robbed of many objects.

As we anticipated in our last issue, M. Berthelot has been nominated a life-member of the French Senate almost unanimously. It may be noted that it is just twenty years since M. Berthelot received the great prize of the Academy of Sciences for his method of producing artificially substances which have been found only in living bodies.

A SAD accident has happened in the vicinity of Lyons, where two balloons were sent up on the occasion of the *fête* of July 14. A match having been ignited close to the place where the largest landed, the balloon exploded instantaneously with a fearful crash. Three people were severely wounded.

M. DE MÉRITENS, the well-known electrician, tried a new system of electrical illumination on the occasion of the festivities of July 14. He suspended his regulators between two poles placed on each side of the Boulevard des Italiens and fifty feet high. A series of four of these regulators were placed at a distance of about 200 feet from each other. The effect was much approved by a large number of people.

A SPECIAL competition has been opened for erecting a statue to Carnot, the celebrated mathematician and politician of the First Republic. The number of competitors exceeds fifty, and some of the works sent are highly creditable to their authors. The statue is to be erected by public subscription at the birthplace of Carnot, Nolay, in Côte d'Or.

OUR Paris correspondent informs us that Philippart and Sons are preparing to work tramways at Roubaix with improved Faure batteries, and that experiments will also shortly be made in London. Our correspondent witnessed some preliminary experiments which he thinks give room for high expectations. One of the most important changes is the substitution of flat for round sheets, which produced numerous cracks in the minium coating, and had been resorted to in imitation of the old Planté batteries.

AT the anniversary meeting of the Sanitary Institute of Great Britain held at the Royal Institution, Albemarle Street, on Thursday, July 14, the Right Hon. Earl Fortescue in the chair, an address was delivered by Prof. F. S. B. F. de Chaumont, M.D., F.R.S., chairman of the Council, entitled "Modern Sanitary Science," and the medals and certificates were awarded to the successful exhibitors at the exhibition held at Exeter in October, 1880.

THE forty-seventh anniversary meeting of the Statistical Society was held in the Society's rooms, King's College, Strand, on the 28th ult., Dr. W. A. Guy, a past president, in the chair. The report was highly satisfactory, showing that in the last decade the number of Fellows, the income, and the amount invested have been more than doubled, while the expenditure had increased in a less ratio A new edition of the Library catalogue is being prepared. Ten papers had been read during the year. The president for 1881–82 is James Caird, C.B., F.R.S.

A SECOND earthquake is reported from Metkovich (Dalmatia). It was observed on June 14 at 5.27 a.m. During the night of May 17 a violent shock occurred in Haiti, causing several landslips, through which a large number of cattle perished. The volcano in the Gulf of Santorin, which has been inactive since 1870, again began to eject vapour on May 30 last. This activity increased considerably on June 2. The sea between Pala and Aeo Kaymene has again become heated. Earthquakes are reported from the east coast of Tunis. It is stated that since June 10 last Gabes and neighbourhood was visited by a great many violent shocks, some recurring at very short intervals. The last shock was felt during the night of June 22-23. The mountains in the neighbourhood of Gabes are of volcanic nature; smoke rises during the night from the Ay-Buin Mountain (about 30 kilometres to the north-west of Gabes), and at Hamma, 18 kilometres from Gabes, there are hot springs. Shocks of earthquake are reported from different places in Dalmatia: Ragusa on July 4, at 10.28 a.m.; Budua, Castelastua, Sutomore, on July 4, at 10.19 a.m. and 1.53 p.m.; duration, two to four seconds; direction, north to south.

THE growth of American journalism is shown by recent census results to have been much more rapid than that of English. In 1824 there were eleven daily newspapers in Philadelphia and twelve in New York, with a circulation varying from 1000 to 4000 copies. To-day the State of New York has 115 daily newspapers and 84 weeklies, with a combined annual circulation of 384,328,454; and Pennsylvania 98 daily newspapers and 57 weekly papers, with a combined circulation of 202,539,482. There are 962 daily newspapers in the United States, and 803 weekly, semi weekly, tri-weekly, and Sunday newspapers. The total circulation of all newspapers is estimated to be 1,344,101,235, the bulk of which is in ten great States.

FROM a recent U.S. Census Bulletin relating to the Fishery Industries of the Pacific States and Territories (California, Oregon, Washington, and Alaska) we gather that the total number of persons engaged in these fisheries is 16,745, of whom 7910 are Esquimaux, Aleuts, and Indians, and about 4000 Chinese. A capital of over 2½ million dollars is invested in vessels, boats, apparatus, building, &c. There are 53 vessels and 5547 boats. Among other items in this Bulletin we note that the number of salmon caught in 1880 (to which all these numbers refer) was 2,755,000, with a total weight of 51,862,000 lbs. The number of sealskins obtained was 155,718, valued at 1,540,912 dollars.

M. FERRY has ordered the teachers of elementary classes of the colleges to conduct their pupils into the galleries of the Museum of Natural History at Paris, to explain to them the differences of the several kinds of animals, plants, and minerals, and to incite young pupils to collect specimens during their walks in the country round Paris.

AN attempt at silk cultivation is to be made at Akaron, New Zealand, the valleys and bays of Banks' Peninsula being considered well suited for that purpose. The Colonial Government are sending to California and Japan for silkworms' eggs and mulberry trees of the best kinds, with the view of encouraging the industry.

THE *Colonies and India* reprints from a New Zealand paper some notes on a discussion at the Otago Institute, when Prof. Parker exhibited the skin and body of the extremely rare and remarkable bird, *Notornis Mantelli*. The specimen in question is only the third which has ever been captured, was caught low down on the ranges, and it is probable that an expedition will be fitted out to search for more of the species.

A POPULAR explanation of Kant's "Kritik der reinen Vernunft," by Albrecht Krause, has just been published by Moritz Schauenburg of Lahr (Germany), "in celebration of the centenary of the publication of the great work."

AN important invention relating to railway signals has recently been made in Germany, and the model apparatus has just been completed at the central works of the Bergisch-Märkische Railway Company at Witten. The model will be exhibited at the Electro-Technical Exhibition at Paris.

THE additions to the Zoological Society's Gardens during the past week include a Red-handed Tamarin (*Midas rufimanus*) from Surinam, presented by Mr. Keiser; an American Black Bear (*Ursus americanus*) from Nova Scotia, presented by the Earl of Caledon, F.Z.S., and the Hon. Charles Alexander; two Grey Ichneumons (*Herpestes griseus*) from India, presented respectively by Mr. C. R. Smith and Mrs. C. Hassell; a Common Raven (*Corvus corax*), British, presented by Major Botts; a Carrion Crow (*Corvus corone*), European, presented by Miss Mortimer; a —— Monitor (*Monitor*, sp. inc.) from Ceylon, presented by Mr. E. Lindstedt; a Sykes' Monkey (*Cercopithecus albogularis*), three Vulturine Guinea Fowl (*Numida vulturina*) from East Africa, deposited; three Common Peafowl (*Pavo cristatus*), two Cheer Pheasants (*Phasianus wallichii*), two Horned Tragopans (*Ceriornis satyra*), a Siamese Pheasant (*Euplocamus prælatus*), bred in the Gardens.

METEOROLOGICAL NOTES

FROM a discussion by Dr. Hann of a series of hourly summer observations of air-pressure, temperature, moisture, cloudiness, and force of wind made by the U.S. Engineer Corps on the plateaux of the Rocky Mountains (the stations lying between 3500 and 8500 feet above the sea), it appears that in valleys and wide basins, even at the greatest height, the influence of the daily barometer oscillation in summer is still very great, and no decrease with the height is noticed. The course of the curve is of the continental type, a comparatively large afternoon minimum, a slightly marked morning minimum, and an earlier occurrence (7 to 8h.) of the morning maximum. In the temperature-curve the most notable point is that the maximum is very near midday, or little behind the culmination of the sun. The maximum of absolute moisture occurs about 8 a.m., and a second smaller maximum in the afternoon or evening. The maximum of cloudiness and wind-force occurs between 3 and 4 p.m., the minimum between 3 and 4 a.m.

IN a letter dated April 14, Mr. Russell of the Sydney Observatory remarks that the rain return for 1880 shows it to have been a dry year in New South Wales, as in many other parts of he world; but the want of rain was not severely felt because it came at favourable times for grass. Perhaps the most curious consequence of the short supply of rain was the stoppage of the river navigation for a considerable part of the year, thus preventing the wool from going by steamer to market, and increasing the cost of all stores consumed: the river curves show, for instance, that at Bourke the water was at summer level from June to October, thus preventing navigation. Mr. Russell hopes, by the combination of the rain and river observations, to find an answer to a local question of very great importance, viz. the *amount* and *source* of the water found in wells which are being sunk by the hundred in the inland parts of the colony. There can be no doubt that all, or nearly all, the water brought down in such abundance from Tropical Queensland by the Culgoa, Warego, and Paroo Rivers sinks into the ground before it reaches New South Wales, and there is good reason for thinking that much of the water brought down by the heads of the Darling sinks into the ground before it reaches Bourke. If this can be proved, which he thinks can be done in the course of a few years, there will be no fear for the abundance and permanence of the well-water. And when it is remembered that in most cases the water rises to within thirty or forty feet of the surface, in many instances to the surface, and in one case twenty-six feet above the surface, the local importance of the question will be obvious.

IN studying the conditions of temperature of the Russian Empire some time ago, M. Wild found that the irregular distribution of temperature revealed by the isotherms might be elucidated by means of "isanomals" (or lines of equal temperature-anomalies). Among the causes of the isanomals special regard must be had to the wind, which again immediately depends on the distribution of air-pressure, as shown by the isobars. A comparison of the lines of equal pressure with the lines of temperature-anomalies thus suggested, led M. Wild to recognise an intimate relation between the two systems. Reasoning from the results arrived at, he has attempted with some success to rectify the isobars over certain regions, where from want of observations their course was somewhat uncertain; and further has even suggested the probable existence of a pressure-maximum in Northern Siberia, of which region however little if anything is positively known, owing to the want of barometric observations. M. Wild's paper, which is of a provisional nature, appears in the *Bulletin* of the St. Petersburg Academy. (It is noted that M. Teisserene de Bort, in the Paris Academy, has to a certain extent been prosecuting the same subject.)

AS an evidence of the great cold of last winter Mr. Angus M'Intosh, Schoolhouse, Laggan, states in the *Scotsman*, that on June 20 the Balgown peat moss in that parish was still frozen at the depth of 2½ feet beneath the surface.

THE *aurora* has been remarkably frequent at Stykkisholm, Iceland, last winter. From September 5, when the first aurora of the season was observed, to February 28, to which date the observations have been received, auroras were seen on forty-five nights, viz., five in September, eleven in October, four in November, eight in December, twelve in January, and five in February, the phenomena being very brilliant on September 29, December 23, January 31, and February 5.

FOR some time the Registrar-General has been printing in his weekly returns the deaths from small-pox in London under three heads, viz., the vaccinated, the unvaccinated, and those regarding whom no statement is returned. The results show for the whole mortality from small-pox substantially the small-pox curve as given in NATURE (vol. xxiv. p. 144), with its characteristic saddle-shaped maximum, the dip between the two heights of the curve being towards the end of March. On projecting curves of the death-rates for the vaccinated and the unvaccinated, it is seen that the dip in the curve for the whole mortality is due to a diminution of the deaths of the unvaccinated during March as compared with what occurred before and after. In other words, those climatic influences which raise the mortality from small-pox to the annual maxima, first in January-February, when the weather is coldest, and again in May when driest, bear with more fatal effect on the unvaccinated than the vaccinated. As fatal terminations in small-pox cases arise chiefly from complications with other diseases, and as the times of maxima of the curve point to diseases of the nervous system and the respiratory organs as those mostly concerned, even one year's results, particularly a year with cold and dryness so unusually pronounced, may be pointed to as warranting an inquiry of some importance into the relations of the vaccinated and unvaccinated to attacks of small-pox.

SOLAR PHYSICS—THE CHEMISTRY OF THE SUN[1]

I.

WHEN we have familiarised ourselves with the general phenomena presented to our notice by the analysis of the light proceeding from different sources, and wish to apply this know-

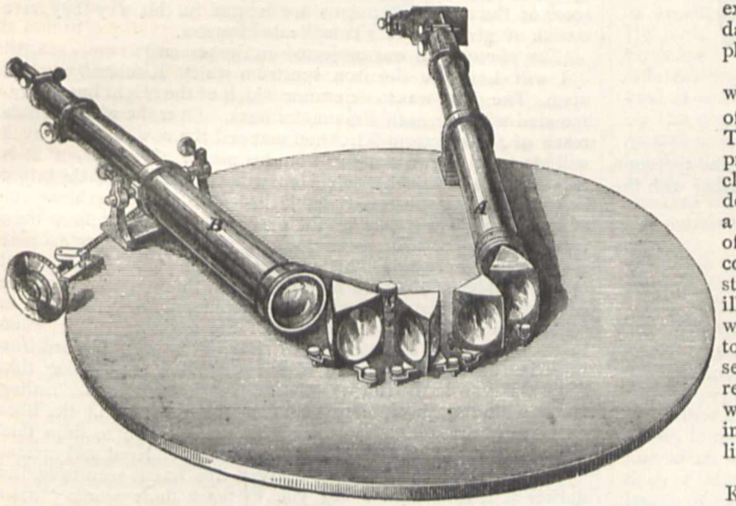


FIG. 1.—Steinheil's form of four-prism spectroscope. A, collimator; B, observing telescope.

ledge to the study of the sun, the first work to which attention must be given is a very admirable memoir of Kirchhoff (1861).[2]

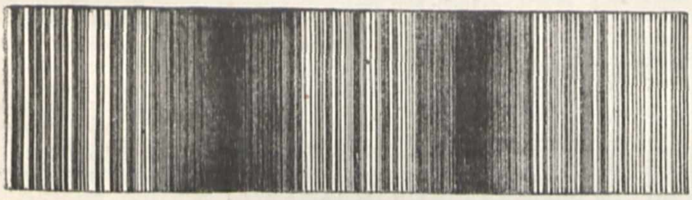


FIG. 2.—Copy of a photograph of the solar spectrum in the region of the thick calcium lines, by Lockyer.

In this, after referring to the prior work of Fraunhofer and others, he goes on to show that the same principles which had then been employed to suggest the extreme probability of the existence of sodium in the atmosphere of the sun, and the probability, therefore, that the dark line D, which we see in the spectrum, was caused by the absorption, by the cooler sodium vapour, of light proceeding from the solar nucleus which was hotter than the vapour; might be applied to other substances, such as iron, cobalt, nickel, and so on; and that if these were experimented on in the same manner, other of the dark lines in the solar spectrum might be explained.

Now I propose, in the first instance, to show what Kirchhoff saw, and what he did—his manner of work. Kirchhoff, and after him Ångström and Thalèn, to whom further reference will be made presently, used spectroscopes placed close or nearly close to the source of light. Kirchhoff's work was done by a spectroscope of this model. We have a slit and collimating lens, a train of prisms, which, of course, during the observations are carefully covered up, and the observing telescope. This instrument may be turned to the sun, or to a cloud illuminated by the sun in case the quantity of light which enters the instrument when turned directly towards the sun is too great to allow of easy observation; or light from the sun or a cloud may be reflected into the instrument by a mirror. Kirchhoff was enabled by means of properly contrived measuring apparatus to map down the positions of the lines observed.

Let us see, first of all, what kind of thing Kirchhoff saw. To give an idea of this I propose to throw on the screen photographs of that portion of the spectrum which is not so readily observable as that upon which Kirchhoff began his work. Here then is an absolutely untouched photograph of a part of the solar spectrum in the blue and violet (Fig. 2). We get in great prominence in the spectrum two very thick lines, which are called H and K, the precise position of which in the solar spectrum are shown by means of the diagram of the spectrum (Fig. 3). By moving his observing telescope along the spectrum, as it were, the telescope being furnished with a delicate micrometer, or some properly-contrived means for defining the exact position of each line, Kirchhoff was in that way able to prepare a map of the whole spectrum. Indeed he did prepare this map with the object of providing himself with a scale of extreme value for the future work which he then laid out for himself. The future work being this:—he wished to determine the positions of the bright lines given by the different chemical elements; having got this information, he

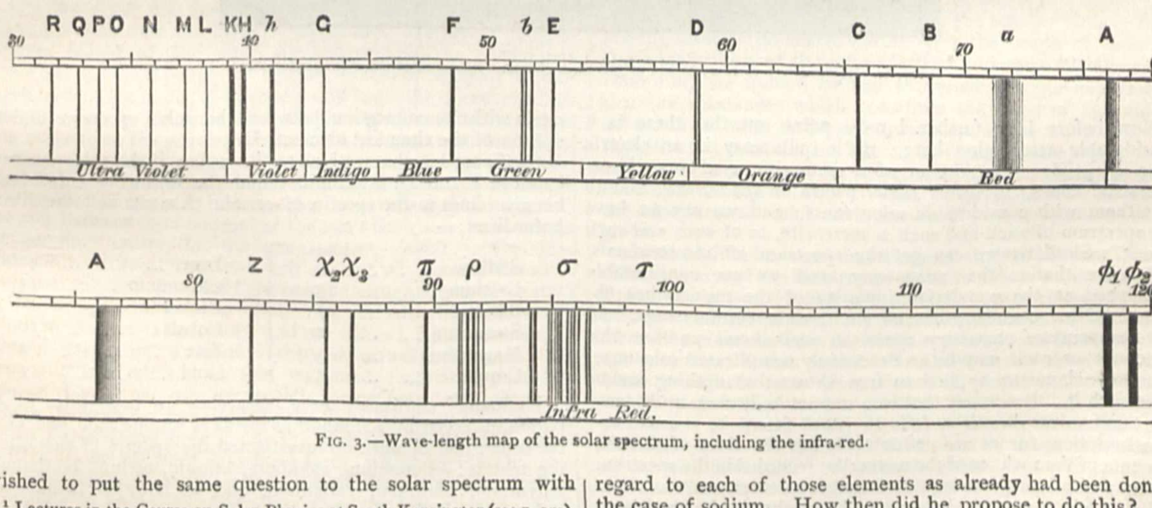


FIG. 3.—Wave-length map of the solar spectrum, including the infra-red.

wished to put the same question to the solar spectrum with regard to each of those elements as already had been done in the case of sodium. How then did he propose to do this? He made an addition to the slit of the spectroscope, such as was then employed. He put a prism in front of it, by means of which he illuminated one half of the slit with the direct light of the sun, and the other half with the light from the vapour employed

[1] Lectures in the Course on Solar Physics at South Kensington (see p. 150). Revised from shorthand notes. The first lecture is omitted, as it dealt with the general principles of spectrum analysis.

[2] "Researches on the Solar Spectrum and the Spectra of the Chemical Elements." *Transactions* of the Berlin Academy for 1861. Translation by Prof. Roscoe (Macmillan, 1862).

reflected on to that other half by means of the prism. You will see in a moment, therefore, that it was quite easy by this

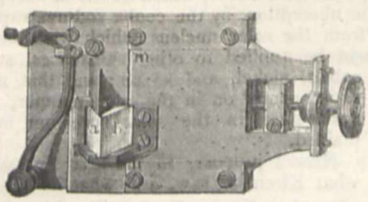


FIG. 4.—Steinheil's slit, showing reflecting prism.

method to see in his observing telescope no longer the spectrum of the sun alone, but the spectrum of the sun together with the

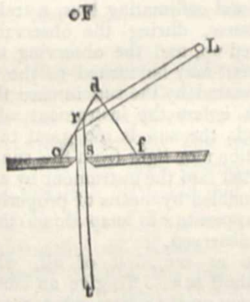


FIG. 5.—Path of light through comparison prism. *d f o*, prism, *l*, light source; *r*, point of reflection; *s*, slit; *r*, light source in front of slit.

spectrum produced by each of the chemical substances which he chose to experiment upon.

Again, anticipating matters somewhat, I can show you something like what Kirchhoff then saw—only again I give you a photograph, and therefore we have a part of the spectrum with which he did not begin his work. In the lower half of this slide we have the solar spectrum. There are the two lines H and K, and in the upper portions we have the bright lines given us by a metallic element—in this case cerium. You see when some of the metallic elements are treated in this way they have a trick of giving us very complicated spectra.

(The photograph was projected on the screen.)

I will show you the iron spectrum which Kirchhoff worked upon. The point was to determine which of the bright lines corresponded with the dark Fraunhofer lines. Over the whole visible reach of the spectrum Kirchhoff mapped the results, for iron; I will give one or two extracts from his paper. He says,[1] "It is specially remarkable that coincident with the positions of the bright lines which I have observed [that is the bright lines from the vapour of iron, using two iron poles with an induction coil] definite dark lines occur in the solar spectrum. By the help of a very delicate method of observation which I have employed, I believe that each coincidence observed by me between the iron lines and the lines of the solar spectrum, may be considered to be at least as well established as the coincidence of the sodium lines." Then he shows, limiting his attention to sixty of the most defined iron lines in the region included in his map, that the betting that there was iron in the sun was about three trillions to one, dealing alone with the absolute matching of the positions of the lines recorded in the solar spectrum. Then he goes on to show that this probability of three trillions to one was rendered still greater by the fact that the brighter a given iron line is seen to be the darker as a rule—and I beg you to mark those words "*as a rule*"—does the corresponding solar line appear. Hence this coincidence must be produced by some cause, and a cause can be assigned which affords a very perfect explanation of the phenomenon. He then gives the cause, which has already been stated by Prof. Stokes.

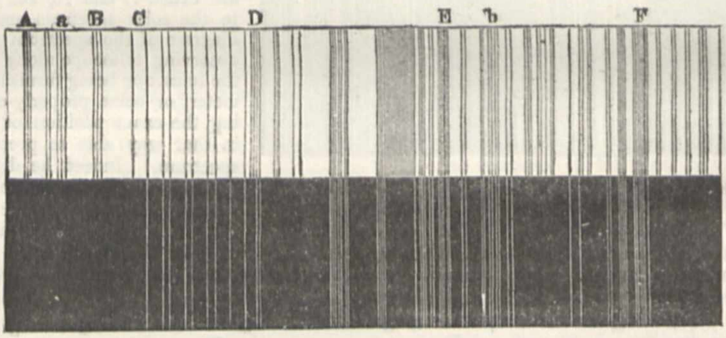


FIG. 6.—Coincidence of some of the bright lines of iron with some of the Fraunhofer lines.

Now before I go further I must point out that there is a considerable assumption here. It is quite easy in an electric lamp to produce the vapour of a meteorite or of any of our terrestrial rocks, to throw their spectra on the screen, and to map them with considerable minuteness; and we say we have the spectrum of such and such a meteorite, or of such and such a rock. Similarly we can get the spectrum of iron terminals, and serve that in the same way, and we are considerably astonished at the wonderful similarity of the results thus obtained. Now chemistry has advanced to a certain stage, and low temperature chemistry comes in and shows us that this meteorite or rock may be an excessively complicated substance. The same chemistry applied to iron shows that nothing can be done with it. But to say that iron cannot be broken up because low temperature chemistry fails to break it up is, you will see, an assumption, for as we undoubtedly get the lines of the constituents of the rock, or of the meteorite, recorded in the spectrum, we may also be registering the lines of the constituents of iron; and it is fair to say this, because we know that in the electric arc we have a stage of heat at which at present no experiment whatever has been made.

Passing on from that point, however, I will ask you to consider somewhat more in detail that part of Kirchhoff's work which deals with the connection between the solar spectrum and the spectra of the chemical elements.[2]

Confining his observations to the region of the solar spectrum between F and D, Kirchhoff found the following coincidences between lines in the spectra of certain elements and the Fraunhofer lines:—

	Lines.		Lines.
Sodium	2	Iron	42
Calcium	13	Chromium	4
Barium	7	Nickel	28
Strontium	2	Cobalt	10
Magnesium ...	3	Zinc	2
Copper	3	Gold	1

Hofmann[3] continued these researches on both sides of the region observed by Kirchhoff as far as A on one side and G on the other, and in addition investigated the spectra of the following metals:—Potassium, rubidium, lithium, cerium, lanthanum, didymium, platinum, palladium, and an alloy of iridium and ruthenium. Hofmann added the following coincidences between

1 "Researches on the Solar Spectrum." Roscoe's translation, Part I., p. 18.

2 Kirchhoff's "Researches," translated by Roscoe, Part I., Supplement.

3 *Ib.*, Part II., Appendix.

lines of the spectra of the different chemical elements and the dark solar lines :—

	Lines.		Lines.
Calcium	16	Chromium	0
Barium	5	Nickel	4
Strontium	2	Cobalt	4
Magnesium ...	0	Zinc	3
Copper	1	Cadmium	2
Iron	31	Gold	1

The spectra of the additional metals examined gave the following coincidences :—

	Lines.		Lines,
Cerium	2	Platinum	1
Didymium	2	Rubidium and Iridium	1
Lanthanum ...	1		
Palladium	2		

The potassium spectrum could not be obtained by moistening the electrodes with salts of this metal, and when poles of the metal were employed the spectrum was so very feeble that only two prisms could be employed, and hence the position of the lines with regard to the solar lines was not easily determined. He noted that the line K*α* was better seen if the Bunsen flame was used instead of the electric spark.

In conclusion Kirchhoff and Hofmann state that, although the additional observations have added nothing to what the previous work had taught, they have confirmed the results of the previous examination. A large number of lines of iron and of calcium occur in the yellow and the blue, and all these were found coincident with well-defined Fraunhofer lines. The probability that nickel is present in the solar atmosphere is greatly increased by the number of new coincidences observed. Cobalt remains doubtful, the solar lines coincident with a considerable number of its bright lines not having been observed. New coincidences in the spectra of barium, copper, and zinc with dark solar lines confirm the presence of those elements in the sun's atmosphere. In the cases of strontium and cadmium the number of coincidences seemed to be too small to warrant the conclusion that those metals are in the sun. The other chemical elements examined, including potassium, did not appear to be visible in the solar atmosphere. The case of potassium however they consider as doubtful, since faint solar lines are very near the red potassium lines.

Note that the passage from the spectrum of the spark to the spectrum of the sun lands us in doubt in many instances.

Kirchhoff next discusses the bearing of this work on the physical and the chemical condition of the atmosphere of the sun. Of course this at once destroyed, at a blow, the idea of Sir William Herschel that the sun was a cool habitable globe with trees, and flowers, and vales, and everything such as we know of here. If the atmosphere were in a state of sufficient incandescence to give these phenomena it was absolutely impossible that anything below that atmosphere should not be at the same time at a higher temperature. He says, "Judging of the height of the solar atmosphere from the phenomena observed in a total eclipse of the sun, it cannot be small in comparison with the radius of the body, and hence the distances which two rays have to pass, one of which proceeds from the centre, and the other from the edge of the disk, do not greatly differ." That was a reply to an objection which had been urged to the effect that if a dark line had been produced by anything absorbing in the atmosphere of the sun, there would be a very considerable difference between the spectrum of the sun's limb and the spectrum of the sun's centre, for the same reason, *ceteris paribus*, that the sun is white at noon-day and reddish at sunset; for since our atmosphere is thin, the light passes through a greater stratum in the one case than in the other. At the sun the light would have to do the same thing, and we should get, therefore, a greater darkening of the limb than is actually observed. He says :—"In addition to this we must remember that the lowest layers of our terrestrial atmosphere are those in which the distance traversed by the light increases most rapidly when approaching most nearly the horizon ; for the solar atmosphere, on the contrary, it is those layers which are elevated to a certain position above the solid crust of the sun which are more energetic in producing dark lines than the lower layers which possess a temperature slightly different, and effect but little alteration on the light." He therefore places the region where this absorption takes place at a considerable elevation in the atmosphere of the sun. His notion is that the sun we see is what gives us the continuous spectrum the light of which is absorbed ; that above that there is a haze different in structure from it, and yet not competent to give us the absorption lines ; that practically none of the absorption phenomena arise from that stratum, but that above this very luminous region of haze the absorption phenomena take place. Such was Kirchhoff's view.

We now pass on for some years to the next step, the work of another eminent man no longer amongst us, Ångström.[1] He took up very nearly the same work as Kirchhoff did, and extended it in certain directions ; but he did the work in a different way instrumentally. He was not content with the kind of scale which Kirchhoff had employed, a scale dependent on the construction of his instrument. He wished to have a natural scale. He therefore rejected the use of prisms, and used a diffraction grating. By means of this he obtained what was called, and what is still called, a normal spectrum ; and having obtained this he, as Kirchhoff had done before him, endeavoured to determine the coincidence, or want of coincidence, of metallic lines.

By the use of these diffraction gratings measured with great care and expressed in terms of the standard metre, along with a collimator and reading-telescope, the latter fitted with a micrometer screw which enabled the operator to determine with great accuracy the angle through which it moved, Ångström was able to determine with great exactness the wave-lengths of the more prominent line of the solar spectrum from A to H. Using these lines as starting-points he was able, by means of the micrometer, to measure the angle between any of these points and any line which lay between them, and then writing these determinations in interpolation formulæ he was able to compute the wave-length of any observed solar line.

The wave-lengths are given to the second decimal place, the unit being $\frac{1}{10000000}$th of a millimetre.

In the atlas which accompanies this memoir of Ångström the scale is divided, so that one division corresponds to $\frac{1}{10000000}$th of a millimetre of wave length. In addition to marking the wave-lengths of the solar lines, their relative intensities are shown. The map also shows the origin of each line and its correspondence with the lines of metallic spectra so far as these have been determined by Ångström and Thalèn.

The following is a summary of the coincidences observed[2] :—

	Lines.		Lines.
Hydrogen	4	Manganese... ...	57
Sodium	9	Chromium	18
Barium	11	Cobalt	19
Calcium	75	Nickel	33
Magnesium ...	4 (3?)	Zinc	(2?)
Aluminium ...	2 (?)	Copper	17
Iron	450	Titanium	118

Ångström remarks that the number of these lines, about 800,[3] might easily be increased by raising the metals to a higher stage of incandescence. Still, he observes, the number already found is quite sufficient to enable him to refer the origin of almost all the stronger lines of the solar spectrum to known elements, thus confirming the opinion he had expressed in a previous memoir, that the substances which constitute the mass of the sun are doubtless the same as those forming that of the earth. But, he says, the fact must not be lost sight of that there exists, nearly midway between F and G, strong solar lines of which the origin is entirely unknown : still it would be premature to assert that the substances to which these are due are not constituents of our globe.

Of aluminium he says[4] that although it gives brilliant lines in different parts of the spectrum, yet the two lines situated between Fraunhofer's two H-lines are the only ones which appear to coincide with solar lines. By way of explanation of this phenomenon he points out that the violet rays are much the strongest in the spectrum of this metal. He observes that these two lines often present the same phenomenon of absorption as is shown by the yellow sodium lines, which is a proof of their great intensity. He states finally that the point will be cleared up by ascertaining whether the ultra-violet lines of aluminium coincide or not with faint solar lines in that region.

Of zinc he remarks[5] that the two lines he has given of that metal as coincident with solar lines do not correspond with the latter in character, being wide, very strong and nebulous, so that

1 "Recherches sur le Spectre Solaire" (Upsal, 1869).
2 *Ib.*, p. 35.
3 *Ib.*, p. 36.
4 *Ib.*
5 *Ib.*

the presence of zinc in the sun remains doubtful. It is noteworthy, however, that there are three lines in the magnesium spectrum which present the same nebulous appearance, and to which there are no corresponding solar lines, and yet magnesium is undoubtedly present in the sun.

Kirchhoff's and Ångström's maps are in all our laboratories, and there is a very considerable difference between them. This difference arises from the fact that whereas Kirchhoff used an induction coil and spark, Ångström varied his experimental method by placing no longer a spark, but the electric arc in front of the slit of his instrument. In this case, therefore, he was determining the spectrum which was produced at the temperature of the electric arc instead of the spectrum which was produced at the temperature of the induction coil. The result of their combined attack is shown in the accompanying table :—

Elements present in the Sun

Kirchhoff.	Ångström and Thalèn.
Sodium.	Sodium.
Iron.	Iron.
Calcium.	Calcium.
Magnesium.	Magnesium.
Nickel.	Nickel.
Barium.	—
Copper.	—
Zinc.	—
	Chromium.
	Cobalt.
	Hydrogen.
	Manganese.
	Titanium.

So far then for that mode of observing the sun which consists in comparing the total light of the light-source with the total light of the sun.

This introduces an important consideration. When we have a light source placed in front of the slit of the spectroscope it is perfectly clear that light from all portions of the light source must illuminate the slit. Similarly, if we content ourselves by pointing the spectroscope to the sun, or to a cloud illuminated by the sun, it is perfectly obvious that the light from all parts of the sun must enter all parts of the slit.

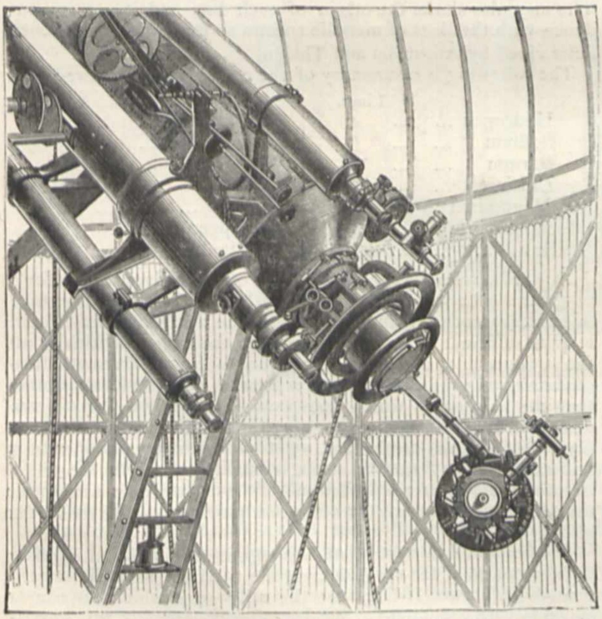


FIG. 7.—The eyepiece end of the Newall refractor (of 25 inches aperture) with spectroscope attached.

Is there any other way of observing the sun along with the light source? You will see in a moment that there is. *We can throw an image of the sun on the slit of the spectroscope.* This work was begun in 1866. If an image of the sun contains, let us say, a spot or a facula, we can see it when we throw it on to the slit. If we can manage to do so we shall get the spectrum of the sun-spot as distinguished from the spectrum of the other portions of the sun, or we shall get the spectrum of the facula as opposed to the spectrum of the other portions of the sun. The manner in which this kind of work is carried on is easily grasped. It simply consists in the use of a spectroscope of large dispersion attached at the focal point of a telescope of considerable power. Here is the eye-piece end of Mr. Newall's refractor, with a spectroscope, with a considerable number of prisms, fixed to the telescope by means of an iron bar, with the slit of it in the position of the focus, so that when the instrument is pointed towards the sun we see an image, in the case of this telescope something like four inches in diameter, with the spots and brighter portions wonderfully and beautifully clear, and by means of the different adjustments of the telescope we can bring now a spot, and now one of the brighter portions of the sun on to the slit, and see if there be any difference between the spectrum of the spot and the spectrum of the general surface of the sun.

If we wish to observe two adjacent spots and compare their spectra, we can rotate the spectroscope and look at both. Again, anticipating matters, I can show what we see to a certain extent, for latterly we have been fortunate enough to obtain some photographs of the spectra of sun-spots.

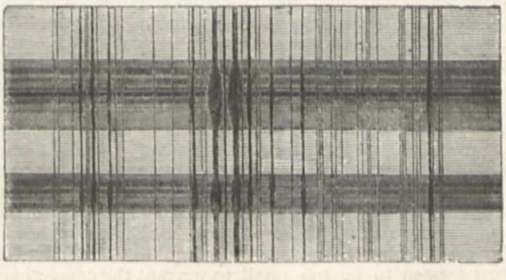


FIG. 8.—Spectrum of Sun-spot, showing the widening of the D lines.

The dark portion gives us the spectrum of the spot throughout the whole length of the spectrum. That is a case of continuous absorption. The continuous radiation of the sun is cut off, but independently of this continuous absorption some of the lines are considerably thickened in the nucleus of the spot (Fig. 8). Now the lines observed in the first instance were the lines of sodium, and the point of the observation was this. Two rival theories had been suggested to explain how it was that the sun-spot was dark. One school said it was due to absorption, and another that it was due to the defect of radiation from the interior gases of the sun. If we had been dealing with defective radiation, we should still have been dealing with radiation, and should have expected to see bright lines; but no obvious bright lines were seen in the spectrum of the spot; what we did see was the thickening and darkening of the lines and the continuous absorption. In the case of the lines of sodium it was very marked; so that we were perfectly justified in saying that the sun-spot was really not produced by any defect of radiation, but was truly and really produced by an increased amount of absorption.

I hope to show you that we can vary the thickness of this line in precisely the same way that it is varied in the different sun-spots, and if then we examine the conditions under which we can experimentally make the line thicker, we shall in that way get some explanation of the thickening of the line in the solar spot. This experiment is rather a difficult one. We will volatilise some sodium in the electric arc and throw its spectrum on the screen. I hope to show that the absorption line is very thick to start with, and then it becomes very thin; if I give it time it will thin down gradually. What is the cause of the thickening and the thinning? It is perfectly obvious. The temperature is practically the same all the time, but we have a very considerable quantity of sodium vapour surrounding the incandescent poles in the first instance. On the further application of the heat this sodium vapour goes away by degrees, and we gradually deal with a smaller quantity, and as we deal with a smaller quantity the line thins. We therefore are justified in saying that when in a sun-spot we get the line of sodium considerably thickened, that is due to the fact that in a sun-spot there is a greater quantity of sodium vapour present.

That was the first experiment with which I am acquainted which enabled us to locate chemical phenomena in any particular part of the sun.

Now although in the year 1866 a great many people were familiar with the spots on the sun, those who had been favoured by a sight of a total eclipse, and many more who had read the accounts of total eclipses, knew that there was a great deal more of the sun than one generally sees. From the time of Stannyan, who observed the prominences at Berne, down to the year 1842, let us say, several eclipses had been observed, and very beautiful coloured phenomena had been recorded by different observers. Red things had been seen projecting round the dark moon during the time of eclipse, and although many held them to be beautiful effects produced by the passage of the moon over the sun, or even clouds in the atmosphere of the moon coloured by the strange way in which the solar light then fell upon them, a larger number of people, on the other hand, insisted that these things must really belong to the sun. Now if that were so, it was perfectly clear that we should not be contented with merely observing the chemical nature of the spots.

Having the spectroscope, the things which showed thus, and which up to that time had only been observed during eclipses, would be more or less *felt*, if they were not absolutely rendered visible, by this new instrument; and for this reason: the things seen round the sun during an eclipse were not there for the instant of the eclipse only: they were always there: why did we not see them? The illumination of our own air prevented this. What was our own air illuminated by? By the sunlight. Now whereas increasing dispersion does considerably dim a continuous spectrum for the reason that it makes it extend over a larger area on the screen, it does not dim to any great extent the brightness of a line, so that by employing a considerable number of prisms we ought to be able to abolish the illumination or our air altogether, and in that way we should no longer be limited to determining merely the chemical nature of the spots, we should be equally able to determine the nature of the surrounding solar atmosphere, supposing the phenomena observed during eclipses were really solar, and not lunar or terrestrial.

I will make an experiment with the electric light. I begin with a bright continuous spectrum. We will charge the cup in the lower pole with some vapour which will give us a bright line, in addition to the continuous spectrum due to the poles, and these two things must fight it out between them. If everything goes well what should happen will be this: by first mounting one prism, then two, and then three, the continuous spectrum will be gradually enfeebled, the line keeping the same luminosity during the whole time; we shall find that relatively the line will be much brighter than the continuous spectrum by the time the experiment is concluded. That was the principle which it was suggested would enable the spectroscope to be used in making what have been called artificial eclipses.

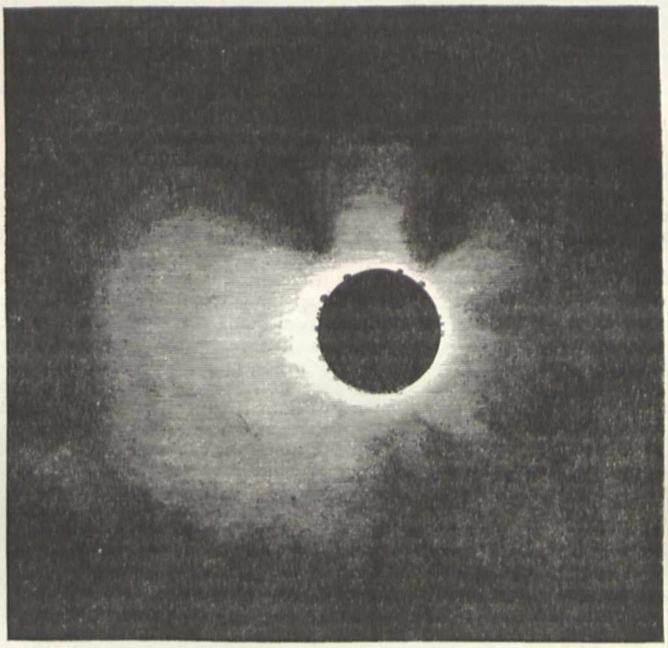


Fig. 9.—Eclipse of 1870. Photograph of the corona taken at Syracuse.

Now if we ask what are the phenomena presented by eclipses, the sort of thing the spectroscope is called upon to observe, we shall see the very considerable advantage of the introduction of the new method. In the first place the eclipses, which are so full of the precious knowledge to be got only at that moment, are almost instantaneous, so far as each particular phenomenon is concerned; and, secondly when the duration is say, four or five or six minutes, which is a very considerable time during an eclipse, and which allows a great deal of work to be done; only a very small part of the more interesting regions of the solar atmosphere is uncovered; one part, of course, when the moon is passing over one limb of the sun, and the other when the moon in passing, liberates it, and brings it into light again. What I would draw chief attention to is the lower part of the brilliant portion seen around the dark moon. We shall have to discuss the upper portion, which is called the coronal atmosphere, or corona, on a later occasion. This mere visual reference, of course, is simply in anticipation of the chemical nature of the different strata upon which we have to operate by the spectroscope, and about which I shall have therefore to tell you in that part of the lecture which has to do with localisation. We shall thus determine, after what has been already said with regard to Kirchhoff's hypothesis as to the position of the region where the lines ought to be seen in the corona, whether during an eclipse we get anything like a justification of this hypothesis. This drawing is really a very beautiful reproduction of an eclipse. We have a round dark moon, which in this case is represented as entirely covering the sun; then these different prominences and luminosities, this wonderful set of streamers, or whatever you like to call them, which seem to veil, or to render less distinct, something else which is lying beyond them. You will see here that some of these prominences are red, and others have a yellow tinge, and that, quite independent of the colour of the prominences, we have the most exquisite coloured effects. Sometimes the radial structure is not so marked, and reveals indications of structure further away from the sun. You see wonderfully delicate tracery, lines being seen now in one part and now in another. In the photograph taken during the eclipse of 1870 we see that the luminosity of the solar atmosphere was excessively irregular, by which I mean that in one part we get a very considerable excess of light, quite independent of the sharply defined prominences, whereas in other portions the atmosphere of the sun at the same height is not nearly so luminous. Now in none of these cases have we been able to see the thing which struck us most clearly the moment the artificial eclipse system was set at work.

The drawings of the eclipse of 1842 show us that before it was possible to observe the edge of the sun without the intervention of the dark moon there was much evidence which went to show that these red prominences or flames, these different coloured phenomena, were really, so to speak, upper crests of an almost continuous sea round the sun.

In the drawings in question, connecting the prominences,

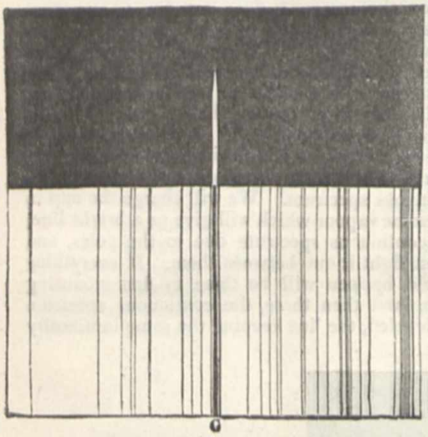


FIG. 10.—Line C (red), with radial slit.

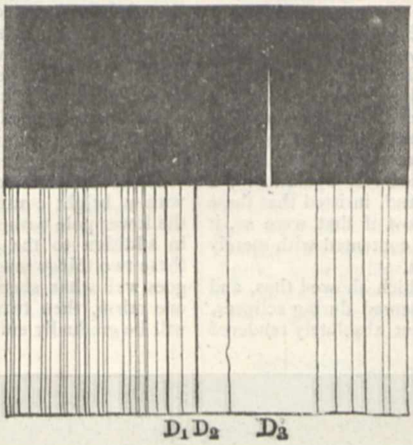


FIG. 11.—Line D_3 (yellow), with radial slit.

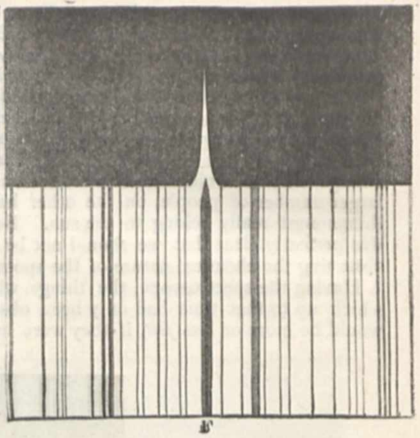


FIG. 12.—Line F (blue-green), with radial slit.

there is a fine low level of the same colour as the prominence itself. The other drawings give us those prominences after the moon had covered all the lower portion, and that is as good an indication as I can think of of the extreme difficulty of making observations during eclipses, and how important it is that one should have a method which makes us independent of them.

How then is this method carried on? It should be perfectly clear that if instead of using our slit to bisect a spot we allow the slit to fall on the edge of the sun, and then fish round it, if the method is competent to abolish the illumination of our atmosphere, to make the bright lines visible, that here and there if we catch a prominence the slit will be illuminated by the light of the prominence; and if we have the image of the sun very accurately focussed on the slit, if we know the size of the image of the sun, and if we know the length of our slit, the length of the slit illuminated by the prominence will enable us readily to determine the exact height of the prominence; so that if it should happen that there is a sort of external invisible sea round the sun usually invisible, but which this new method will pick up, that we shall get the depth of the sea sounded for us by the length of the line on the slit; and further, if that sea is not absolutely level, but if it swells here and there into waves and prominences, the slit will enable us to determine the height of the prominences. Some copies of very early drawings show exactly what is seen when a prominence is thrown on the slit, and show very well the point at which I have been driving.

Again, if we do fish round the sun in this way, and if these prominences really do give us lines, we have exactly the same method of determining the chemical nature of this exterior sea as Kirchhoff employed in determining the composition of the general light of the sun; only we have this great addition to our knowledge in this case, that whereas Kirchhoff had to suggest an hypothesis to explain the possible locus of the region which produced the lines due to the different chemical substances, we have the hard fact beneath our eyes, because if we pass over the prominence, and if it is built up of iron, let us say, then we shall see iron lines; if it is built up of calcium, then we shall see calcium lines, and so on. Now what are the facts? Here is the first observation that was recorded with absolute certainty touching the chemical nature of the exterior envelope of the sun. We find that we are dealing with the line C; and although Kirchhoff did not tell us the origin of this solar line, he showed that it was quite possible to determine the origin of the lines even if they were produced by gaseous bodies. Ångström went further, and added gaseous bodies to the subject of his investigation, and he found by using a Geissler tube he got a line in the red exactly coincident with the line C in the spectrum of the sun. When therefore we had such an observation as this, showing one of the lines produced by this external sea, coincident with the C line of the solar spectrum, we knew at once

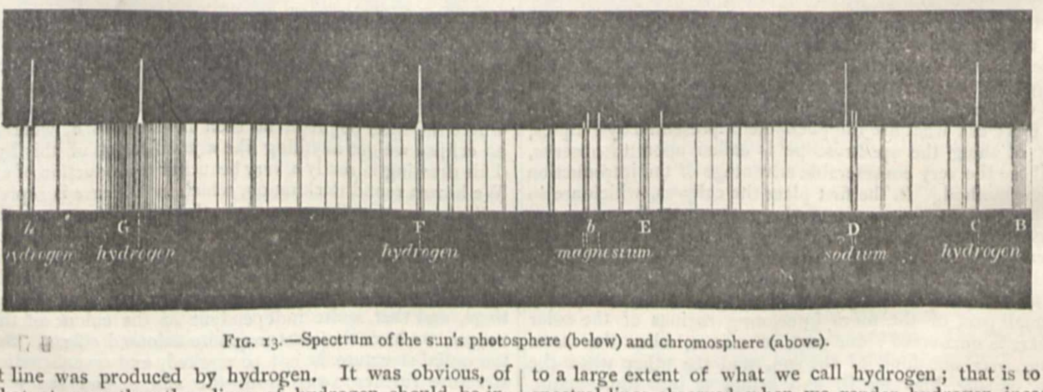


FIG. 13.—Spectrum of the sun's photosphere (below) and chromosphere (above).

that that line was produced by hydrogen. It was obvious, of course, that at once the other lines of hydrogen should be investigated. The next obvious line of hydrogen is F in the blue-green, and when the question was put to this line, in that case also it was found that the prominences gave out no uncertain sound—that the prominences were really and truly composed to a large extent of what we call hydrogen; that is to say, the spectral lines observed when we render hydrogen incandescent are identical with the spectral lines observed when we throw one of the solar prominences on the slit. It was soon found that this continuous ocean, this continuous outer shell of the sun, varied considerably in thickness from time to time, and it was also found that other substances besides hydrogen, some of which at present we know nothing of, others of which we now think we know a great deal of, also appear side by side with the lines of hydrogen. I have already stated that other substances besides hydrogen have been determined to exist in this lower chromospheric layer. In almost all cases, however, we find that these lines are never so long as the hydrogen line, from which we gather that the magnesium sea, to take a case, is a much shallower one than the hydrogen sea. I should further add here that when the sun is moderately active and can be well

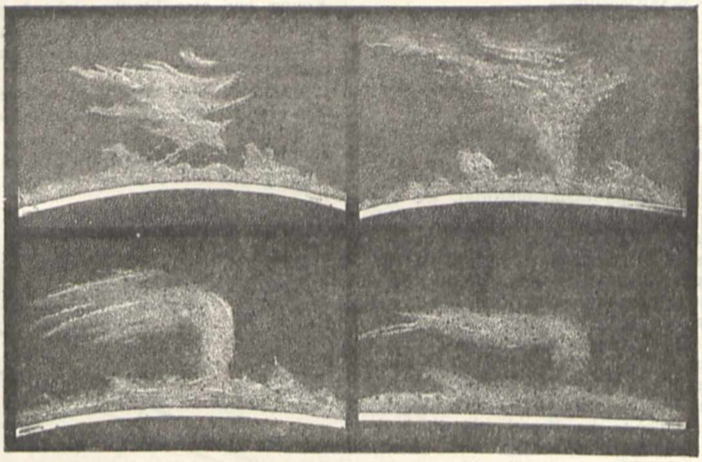


FIG. 14.—Solar prominences (Young), showing lateral currents.

observed, as in a fine climate like that in Italy, this magnesium sea can be detected all round the sun, so that we have in the chromospheric layer, first of all, a sea of hydrogen with its prominences, and then at the bottom of this sea another sea of magnesium, which wells up sometimes where the prominences are strongest.

The different forms which these prominences assume are very striking. You will have no difficulty in seeing that there is really a fundamental difference between them, and that all present us with indications of movement, and these movements enable us to apply a test to the theories of the formation of spots and prominences to which Prof. Stokes referred. Prof.

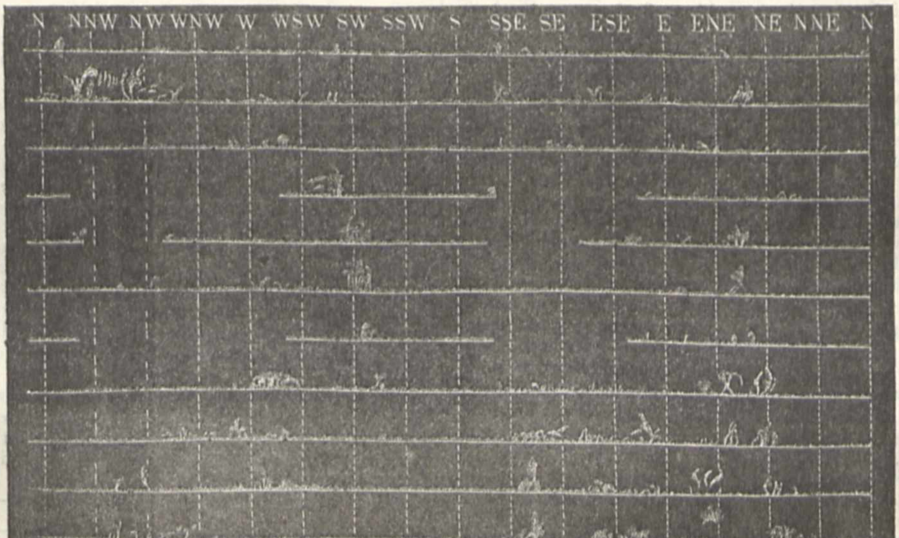


FIG. 15.—Diagram showing how the prominences are daily recorded (Respighi).

Stokes pointed out that a great many phenomena require that the sun-spot shall consist of descending currents, and that these prominences, which when we can see them are fed by the incandescent matter of the sun, should not be descending currents like those in spots, but should be ascending currents,—in fact masses of incandescent vapour shot out from the very bowels of the sun itself. The drawings, which we owe to the skill of Prof. Respighi, drawn by the simple contrivance of opening the slit after we have got the image of the prominence carefully upon it, give us a great many cases of upward movement and lateral movement, sometimes excessively intense, giving indications of their being carried either to the right or to the left of the picture by horizontal currents.

Such then is a first preliminary survey of the method of observing the chemistry of the sun, not as a whole, but of each particular little bit of the sun, chosen here and there, and brought upon the slit of the spectroscope.

J. NORMAN LOCKYER

SOME OBSERVATIONS ON THE MIGRATION OF BIRDS[1]

WHILE showing some friends the astronomical observatory and accessories connected with the College of New Jersey at Princeton, on the night of October 19, 1880, after looking at a number of objects through the 9½-inch equatorial, we were shown the moon, then a few days past its full phase. While viewing this object my attention was at once arrested by numbers of small birds more or less plainly seen passing across the field of observation. They were in many cases very clearly defined against the bright background; the movements of the wings were plainly to be seen, as well as the entire action of flight. In the same way the shape of the head and the tail were conspicuous, when the bird was well focussed. As the moon had not been very long above the horizon the direction of observation was consequently toward the east, and the majority of the birds observed were flying almost at right angles to the direction in which the glass was pointed.

Here then was opportunity for the determination of two points —the kind of birds that were flying, and the general direction in which they were moving. Respecting the first, it was comparatively easy to decide as to what families the species belonged. This point was gained by observing the general shape of the birds, their relative size, the motion of their wings, and their manner of flying; that is, whether the flight was direct or undulating, by continuous strokes of the wings or by an intermittent motion of those members.

Most of the birds seen were the smaller land birds, among which were plainly recognised warblers, finches, woodpeckers, and blackbirds; the relative numbers being in the order of kinds above named. Among the finches I would particularly mention *Chrysomitris tristis*, which has a very characteristic flight; and the blackbirds were conspicuous by the peculiar shape of the tail, from which characteristic I feel most positive in my identification of *Quiscalus purpureus*. I mention such details to explain just how observations were made and conclusions arrived at.

In regard to the second point, with rare exceptions the birds were found to be flying from north-west to south-east. I do not mean that this was absolutely the direction, but that it was the approximate and general one.

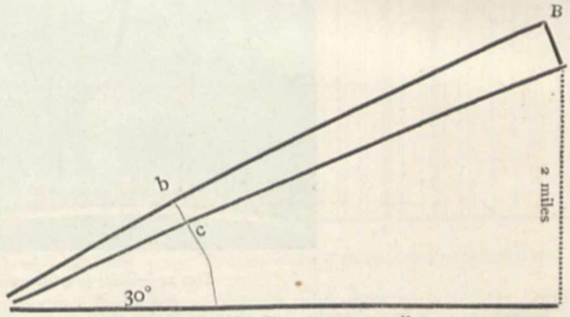
It is not within the scope of the present paper to do more than give details on two other points, namely, the estimated number of birds passing through a given space during a given time, and the height at which the birds were most abundant. For the basis of the first of these points it was necessary to note, first, how many birds passed through the field of observation per minute, and second, how near or how far distant from the glass the birds would have to be in order to be seen at all, that is to be in focus.

The height of the moon above the horizon in degrees and the two limits of the area of observation—that is how near or how far the birds noted were from the glass—supply the data for determining how high the birds seen were flying, and this, combined with the number noted as passing per minute through the field of observation, gives the basis for computing how many birds were passing through a square mile in a given time.

In this connection it may be well to specify how the two limits of observation were defined. The inferior limit, that is, the nearest point where objects could be seen with distinctness, was easily determined by the power of the glass; this is about one mile distant. The superior limit, or the most distant point, is provisionally assumed to be not more than about four miles away, on the hypothesis that the birds would not fly at a greater height than ten thousand feet. It may appear, as future observations are made, that this last limit is not correct, but the reasons for assuming such a height as the superior limit are sufficient to warrant its use in this case, for birds were observed on this same night at a late hour when the height of the moon above the horizon would make the point at which the birds were noted almost at this great elevation, viz. ten thousand feet.

I am greatly indebted to Prof. Charles A. Young for assistance in these observations, and with his aid have arrived at the conclusion that the average number of birds passing through the field of observation per minute was four and a half. Prof. Young has also kindly assisted me with the details of the problem in regard to the limits and area of the field; and the following diagram and computations are from his study of the matter.

Moon's altitude = 30°; moon's semi-diameter = 15′ 05″. The area of observation is a flat triangle = B, A, C. From this must be deducted the small triangle b, A, c, the area within a mile of the glass. The flight of the birds is thought to be nearly at right angles to the field of observation.



Area of triangle B, A, C = 0·07020 miles.
Area of triangle b, A, c = 0·00439 miles.
Therefore b, B, C, c = 0·06581 = $\frac{1}{15.2}$ mile.
Distance from A to B = four miles.
Number of birds seen per minute = 4½.
Number of birds per square mile per minute = 68.

W. E. D. SCOTT

[Mr. Scott's novel and important observations definitely establish on a scientific basis several points in relation to the migration of birds that have heretofore rested almost wholly on conjecture and probability.

We have, first, the fact that the nearest birds seen through the telescope must have been at least one mile above the earth, and may have ranged in elevation from one mile to four miles. It has been held that birds when migrating may fly at a sufficient height to be able to distinguish such prominent features of the landscape as coast lines, the principal watercourses, and mountain chains over a wide area. Of this, thanks to Mr. Scott, we now have proof. It therefore follows that during clear nights birds are not without guidance during their long migratory journeys, while the state of bewilderment they exhibit during dark nights and thick weather becomes explainable on the ground of their inability to discern their usual landmarks—points that have been assumed as probable, but heretofore not actually proven.

These observations further indicate that many of our smaller birds migrate not only at night but at a considerable elevation—far beyond recognition by ordinary means of observation. A promising field is here opened up, in which it is to be hoped investigation will be further pushed, not only by Mr. Scott but by others who may have opportunity therefor.—J. A. ALLEN.]

[1] From the *Bulletin* of the Nuttall Ornithological Club for April.

ON THE EQUIVALENTS OF THE ELEMENTARY BODIES CONSIDERED AS REPRESENTING AN ARITHMETICAL PROGRESSION DEDUCIBLE FROM MENDELEEFF'S TABLES

THE relatively quick succession of new elementary bodies which has marked the last decade of scientific progress and which must be considered as the result of chemical research, pioneered and guided by spectroscopic study, has brought very prominently into notice Mendeleeff's most remarkable law of the periodicity of the chemical elements.

Originally published in Russian in 1871, his memoir has since been translated and reprinted by the author in the *Moniteur Scientifique* (July, 1879), and thence has been translated into some of the English journals.

TABLE I.—MENDELEEFF, *Moniteur Scientifique*, No. 451, p. 692, July, 1879.

TYPICAL ELEMENTS. EXTENDED PERIODS.

Symbols and Equivalents.	Approximate Values of Progression π.	Symbols and Equivalents.	Approximate Values of Progression π.	Symbols and Equivalents.	Approximate Values of Progression π.	Symbols and Equivalents.	Approximate Values of Progression π.	Symbols and Equivalents.	Approximate Values of Progression π.	Symbols and Equivalents.	Approximate Values of Progression π.	Symbols and Equivalents.	Approximate Values of Progression π.	Symbols and Equivalents.	Approximate Terms of Progression π.
						K=39	12½π=39, 27	Rb= 85	27 π= 84, 82	Cs=133 [3]	42⅓π=132, 99		55 π=172, 79		70 π=219, 91 71 π=223, 06
						Ca=40	12¾π=40, 06	Sr= 87	27¾π= 87, 19	Ba=137 [4]	43⅔π=137, 18		56 π=17 93		72 π=226, 19
							14 π=43, 98	Yt= 88	28 π= 87, 96	Di=138 ?	44 π=138, 23	Er=178 ?	56⅔π=178, 02		
						Ti=48 ?	15⅓π=48, 17	Zr= 90	29 π= 91, 10	Ce=140 ? [5]	44⅔π=140, 32	La=180 ?	57⅓π=180. 12	Th=231	73 π=229, 34 73½π=230, 91 74 π=232, 48
						Va=51	16⅓π=51, 31	Nb= 94	30 π= 94, 25		46 π=144, 51	Ta=182	58 π=182, 21		75 π=235, 62
						Cr=52	16½π=51, 81	Mo= 96	30⅔π= 96, 34		47 π=147, 65	W=184	58⅔π=184, 21 60 π=188, 49	Ur=240	76½π=240, 33
						Mn=55	17½π=54, 98	(Terbium ? =99) [2]	32 π=100, 53		48 π=150, 79		61 π=191, 64		
						Fe=56	18 π=56, 55	Ru=104	33 π=103, 67			Os=195	62 π=194, 77		
						Co=59	19 π=59, 69	Rh=104	33⅙π=104, 19	Davyum ? [6]	49 π=153, 93	Ir=197	62⅔π=196, 83		
						Ni=59	19 π=59, 69	Pd=106	33¾π=106, 63			Pt=198	63 π=197, 92		
H=1	⅓π=1, 047	Li= 7	2¼π= 7, 07	Na=23,	7⅓π=23, 04	Cu=63	20 π=62, 83	Ag=108	34⅓π=107, 86	Decipium ?	50 π=157, 08	Au=199	63⅓π=198, 97		
		Be= 9, 4	3 π= 9, 42	Mg=24	7⅔π=24, 08	Zn=65	20⅔π=65, 19	Cd=112	35⅔π=112, 05		51 π=160, 22	Hg=200	64 π=201, 06		
		Bo=11	3½π=10, 99	Al=27, 3	8⅔π=27, 23	(Gallium ?)	22 π=69, 12	In=113	36 π=113, 09			Tl=204	65 π=204, 20		
		C=12	4 π=12, 57	Si=28	9 π=28, 27	(Norwegium ?) [1]	23 π=72, 26	Sn=118	37½π=117, 81		52 π=163, 36	Pb=207	66 π=207, 35		
		N=14	4½π=14, 14	Ph=31	10 π=31, 42	As=75	24 π=75, 40	Sb=122	38½π=121, 95			Bi=208	66¼π=201, 13 67 π=210, 49		
		O=16	5⅛π=16, 10	S=32	10¼π=32, 20	Se=78	25 π=78, 54	Te=125	39½π=124, 09		53 π=166, 50		68 π=213, 63		
		Fl=19	6 π=18, 85	Cl=35, 5	11⅓π=35, 60	Br=80	25½π=80, 11	Io=127	40½π=127, 23		54 π=169, 65		69 π=216, 77		

[1] 72, 2 $=\frac{145, 9}{2}$ approx. See NATURE, vol. xx. p. 304.

[2] *Jahres Berichte der Chimie*, Von Wagner, 1879, p. 7.

[3] 132, 56 Goddefroy, NATURE, vol. xv. p. 282.

[4] 136, 8, *Encyc. Br.*

[5] 141, *Encyc. Br.*

[6] NATURE, vol. xvii. p. 246.

The prevision which it has afforded of yet undiscovered elements, and the fact that the equivalent and properties of gallium correspond with those attributed by Mendeleeff to a then undiscovered metal of one of his series, gives singular importance and weight to this law, and must render it a useful, if not an indispensable guide in the research and determination of further elementary bodies and their equivalents. This point of view has been strongly insisted on by the author in the Chapters iv., v., and vi. of his memoir. In the introductory letter published in the *Moniteur Scientifique* (July, 1879), the author thus speaks of the development of the law:—

"Autrefois ce n'était qu'un schème, qu'un groupement, qu'une subordination à un fait donné, tandisque la loi périodique possède des faits, et tend à approfondir le principe philosophique qui régit la nature mystérieuse des éléments. Cette tendance est de la même catégorie que la loi de Prout, avec cette différence essentielle, que la loi de Prout est arithmétique et que la loi périodique puise son esprit dans un enchainement de lois mécaniques et philosophiques qui constituent le caractère et l'éclat de l'impulsion actuelle des sciences exactes. Elle proclame hautement que la nature des élements depend avant tout de leur masse, et considère cette fonction comme périodique."

Since in all homogeneous bodies the mass is proportional to the volume the consideration of mass leads to and admits that of volume. Therefore the basis of Mendeleeff's law involves the consideration of the volumes of the elementary bodies considered as independent atoms having necessarily limiting forms as well as characteristic weights. Although it may not be possible to fix or define rigorously at present the form of the elementary bodies or atoms when free to move, it is reasonable to admit that the spherical form is that which concords best with the nature of their movements and with their necessary freedom of action.[1]

Parting from this idea, I had been attempting, like many others, to trace out some law connecting the elementary bodies considered as having when free to act a spherical form, but abandoned the idea until I became acquainted with Mendeleeff's law and his Tables. Reverting then to the consideration of the forms and the corresponding relative volumes of the atomic elements, I remarked that a relation could be established between successive elements, as represented by their equivalents given in Mendeleeff's tables, from

[1] See Gauden, "Le Monde des Atomes," p. 32 (1873); also NATURE, vol. xxii. p. 56, "On the Physical Aspect of the Vortex-Atom Theory," by S. Tolver Preston.

the point of view of spherical volume expressed by the simple formula $\frac{4}{3}\pi\nu^3$.

Thus any two spheres being one to the other as γ^3 is to γ_1^3, in atomic elements γ and γ_1 are inconceivably minute, and consequently the values of the two expressions $\frac{4}{3}\pi\gamma^3$ and $\frac{4}{3}\pi\gamma_1^3$ for two given atomic elements if calculated would bear no comparison with the nature of the units by which the equivalents are expressed, while, however, the ratio of their volumes might be adequately represented by entire numbers of the order of the equivalents.

The law of proportionality, according to which the atoms combine, implies that the volumes of the atoms should present

TABLE II.—MENDELEEFF, *Moniteur Scientifique*, 1879, No. 451, p. 701.

Series.	Group I. R²O.	π.[1]		π.	Group II. RO.	π.		π.	Group III. R²O³.	π.		π.	Group IV. RH² RO².	π.		π.
1			H= 1	⅓π= 1,05												
2	Li= 7	2¼π= 7,07			Be=9,4	3 π= 9,42			Bo= 11	3½π= 10,99			C= 12	4 π= 12,56		
3			Na= 23	7⅓π= 23,04			Mg= 24	7⅔π= 24,08			Al=27,3	8⅔π= 27,22			Si= 28	9 π= 28,27
4	K= 39	12½π= 39,27			Ca= 40	12¾π= 40,06					—	14 π= 43,98	Ti= 48	15⅓π= 48,17		
5			(Cu=63)	20 π= 62,83			Zn= 65	20¾π= 65,19			(Gallium ?)	22 π= 69,12			(Norwegium ?)	23 π= 72,26
6	Rb= 85	27 π= 84,82			Sr= 87	27¾π= 87,19			Yt= 88	28 π= 87,96			Zr= 90	28⅔π= 90,06		
7			Ag=108	34⅓π=107,86			Cd=112	35⅔π=112,05			In=113	36 π=113,09			Sn=118	37½π=117,81
8	Cs=133	42⅓π=132,99			Ba=137	43⅔π=137,18			Di=138	44 π=138,23			Ce=140	44⅔π=140,32		
9			(Davyum ?)	48 π=150,79			—	49 π=153,94			(Decipium ?)	50 π=157,08			(Scandium ?)	51 π=160,22
10	—	55 π=172,79			—	56 π=175,93			Er=178	57 π=179,07			La=180	57⅓π=180,12		
11			Au=199	63⅓π=198,97			Hg=200	64 π=201,06			Tl=204	65 π=204,20			Pb=107	66 π=107,34
12	—	70 π=219,91			—	71 π=223,05			—	72 π=226,19			Th=231	73½π=230,91		

Series.	Group V. RH³ R²O⁵.	π.		π.	Group VI. RH² RO³.	π.		π.	Group VII. RH R²O⁷.	π.		π.
1												
2	N= 14	4½π= 14,14			O= 16	5⅛π= 16,10			Fl= 19	6 π= 18,85		
3			Ph= 31	10 π= 31,42			S= 32	10⅕π= 32,04			Cl=35,5	11⅓π= 35,60
4	Na= 51	16⅓π= 51,31			Cr= 52	16½π= 51,84			Mn= 55	17½π= 54,98		
5			As= 75	24 π= 75,39			Se= 78	25 π= 78,54			Br= 80	25½π= 80,11
6	Nb= 94	30 π= 94,11			Mo= 96	30⅔π= 96,34			(Terbium ?)	32 π=100,53		
7			Sb=122	39 π=122,52			Te=125	40 π=125,66			Io=127	40½π=127,23
8	—	45 π=141,37			—	46 π=144,51			—	47 π=147,65		
9			—	52 π=163,36			—	53 π=166,30			—	54 π=169,64
10	Ta=182	58 π=182,21			W=184	58⅔π=184,31			—	59 π=185,35		
11			Bi=208	66⅓π=208,13			—	68 π=213,63			—	69 π=216,77
12	—	75 π=235,62			Ur=240	76½π=240,32			—	77 π=241,90		

Group VIII. RO⁴.	π.		π.
Fe= 56	18 π= 56,55	Co= 59	19 π= 59,69
Ni= 59	19 π= 59,69	Cu= 63	20 π= 62,83
Ru=104	33 π=103,67	Rh=104	33 π=103,67
Pd=106	33¾π=106,02	Ag=108	34⅓π=107,86
—	60 π=188,49	—	61 π=191,64
Os=195	62 π=194,78	Ir=197	62⅔π=196,83
Pt=198	63 π=197,92	Au=199	63⅓π=198,96

[1] Approximate values of equivalents in terms of progression.

some such proportionality, consequently that for a series of atoms their volumes might be expressed by the terms—

$$\tfrac{4}{3}\pi\gamma^3 : \tfrac{4}{3}\pi m\gamma^3 ; \tfrac{4}{3}\pi n\gamma^3, \text{\&c., \&c.,}$$

and therefore stand, one to the other, as the succession of terms—

$$\pi ; m\pi ; n\pi, \text{\&c., \&c.,}$$

that is, be related by a series of terms in function of π.

It may be remarked that this would still be admissible if it be assumed that the forms of the atoms be that of vortex rings as argued in the very remarkable article by Mr. Tolver Preston referred to.

But if such a relation be allowed to exist it is also legitimate to admit a series of which $\frac{1}{3}\pi$, or $\frac{2}{3}\pi$, or π would be the ratio or difference, the law of proportionality being thus still observed. Now taking the simple arithmetical progression having for difference $\pi = 3, 1416$, it furnished a series of terms which markedly concord with the series of the atomic weights or equivalents as presented by Mendeleeff's Tables, and the successive blanks occurring in the series established by him in his Tables are very approximately filled up by the succession of the terms of this progression both as regards numerical values and order of succession.

To demonstrate this Mendeleeff's Tables have been drawn out, with the addition opposite each equivalent of the corresponding approximate value in terms of the progression π.

In Table I., containing his grouping into *Typical* and *Great Periods*, there is shown the succession of the elementary bodies and their equivalents, as also the comparative concordant succession of the terms of the progression π with approximate values mostly in terms of $\frac{1}{3}\pi$.

In the Table II., or of *Periodic Series*, the blanks existing in these series as indicated by Mendeleeff are shown to be very approximately filled up by corresponding terms, in value and order of succession, of the progression π. This is markedly the case as regards the gap existing between the series 8 and 10, where are wanting *twelve terms*, which, being filled up by successive terms of the progression π, the thirteenth term, corresponding to the equivalent of Lanthanum = 180 (?) is represented in the progression π by the value $57\frac{1}{8}\pi = 180, 1164$, or approximatively by the value $57\pi = 179, 0712$.

Considering this progression of terms of π it will be found that of the sixty-five elementary bodies given in Mendeleeff's Tables the following corresponding equivalents are represented, with an approximation of less than a unit, by terms of the progression :—

H	=	1	...	$\frac{1}{3}\pi$ =	1, 0472
Be	=	9, 4	...	3π =	9, 4248
C	=	12	...	4π =	12, 5664
O	=	16	...	5π =	15, 7080
Fl	=	19	...	6π =	18, 8496
Si	=	28	...	9π =	28, 2744
Ph	=	31	...	10π =	31, 4159
Ca	=	40	...	13π =	40, 8404
Ta	=	48 ?	...	15π =	47, 1240
Va	=	51	...	16π =	50, 2656
Fe	=	56	...	18π =	56, 5488
Ni	=	59	...	19π =	59, 6904
Co	=	59	...	,,	,,
Cu	=	63	...	20π =	62, 8313
Zn	=	65	...	21π =	65, 9736
(Gallium ?	=	69·1	...	22π =	69, 1150)
(Norwegium ?	=	72	...	23π =	72, 2566)
As	=	75	...	24π =	75, 3984
Se	=	78	...	25π =	78, 5400
Rb	=	85	...	27π =	84, 8232
Yt	=	88	...	28π =	87, 9648
Zr	=	90	...	29π =	91, 1064
Nb	=	94	...	30π =	94, 2477
(Terbium ?	=	99	...	32π =	100, 5312)
Ru	=	104	...	33π =	103, 6725
Rh	=	104	...	,,	,,
Pd	=	106	...	34π =	106, 8144
In	=	113	...	36π =	113, 0976
Sb	=	122	...	39π =	122, 5224
Te	=	125	...	40π =	125, 6636
Cs	=	133	...	42π =	131, 9472
Di	=	138 ?	...	44π =	138, 2300
Ce	=	140–141	...	45π =	141, 3720
(Davyum ?	=	153	...	49π =	153, 9384)
(Decipium ?	=	157	...	50π =	157, 0795)
Er	=	178 ? }	...	57π =	179, 0712
La	=	180 ? }			
Ta	=	182	...	58π =	182, 2128
Os	=	195	...	62π =	194, 7786
Ir	=	197 }	...	63π =	197, 9208
Pt	=	198 }			
Hg	=	200	...	64π =	201, 0624
Tl	=	204	...	65π =	204, 2040
Pb	=	207	...	66π =	207, 3450

Such a concordance must be taken as some proof of the reality of a certain correspondence between the values of the equivalents and those of the terms of the progression π.

It is fully admitted that the equivalents are but relative, both as regards their number and their numerical values, to the forces which the present state of chemical analysis can bring to bear on matter, and admitting the existence of a law of progression by which the equivalents may be connected, such a progression should as a matter of necessity differ both as regards the number of representative terms and their values from the present received succession and numerical values of the equivalents, and consequently show discordances in certain places and approximate concordances in others; such is shown by the terms of the progression π.

J. P. O'REILLY

May, 1880

BIRDS OF THE SOLOMON ISLANDS

IN a paper "On the Birds of the Solomon Islands," by E. P. Ramsay, F.L.S., &c., Curator of the Australian Museum, Sydney, read before the Linnean Society of New South Wales, February 23, 1881, the following new birds were described :—

1. *Graucalus elegans*, sp. nov.—A species allied to *G. hypoleucus* of Gould, but differing in its smaller size, whiter undersurface, broad jet black band on lorcal region, extending below the eye, and in having ashy grey shoulders.

2. *Piczorhynchus Richardsii*, sp. nov.—A remarkably distinct species, with the body and the wings and tail above black, ossified nape, and hind neck white, head and throat black, chest and remainder of the under surface chestnut; this species comes from the Island of Nyi, and has been named in compliment to Lieut. Richards, R.N.

3. *Myzomela Tristrami*, sp. nov.—A jet black myzomela of large size, the bill strong and yellow, with end black, bases of the inner webs of the quills below ashy. This species is allied to, but distinct from, *M. nigra*, *M. Forbesii*, *and M. pammelana*.

4. *Mygomela pulcherrima*, sp. nov.—This fine species has the whole of the head, neck, chest, breast, and sides of the body and flanks, the interscapular region, rump, and upper tail coverts of a rich deep crimson, the remainder of the plumage black. The extent of the scarlet on the flanks and breast is greater than in either of the allied species *M. cardinalis* and *M. nigriventris*.

5. *Zosterops* (*Tephras?*) *olivacens*, sp. nov.—In this genus there is no trace of white round the eye, and the bill has quite a different contour than that of any species of the genus *Zosterops*. The first and sixth primary quills in this species are equal, and the third is equal in length to the fourth. The general colour above is a uniform dull brown washed with olive, inclining to smokey brown on the head, inner webs of the quills below margined with white, under surface light ashy brown, almost white on the abdomen, length about five inches.

6. *Nasiterna finschii*, sp. nov.—A very distinct species of a uniform grass-green tint, paler on the abdomen, under tail coverts yellow, length 3·8 inches.

The paper contains notes on six or eight other species of interest and a fine collection of Solomon Island birds were exhibited—about fifty species.

OUR ASTRONOMICAL COLUMN

THE VARIABLE STAR χ CYGNI.—A maximum of this variable should now be close at hand. Prof. Winnecke assigns it to July 31, rather later than the average period of the last few years would give it. Its brightness at maximum has varied during the present century from 4m. to a very little above 7m. In vol. vi. of the Bonn Observations, Argelander has given nine observations of the position of this star, about which there has been so much and unnecessary confusion. Its place for 1880·0 is in right ascension 19h. 45m. 57·33s., declination 32° 36′ 42″·1. A comparison of Lalande's observation in 1793 with Argelander's shows that there is no appreciable proper motion. The variability of χ Cygni was discovered in 1686 by Kirch, whose first observed maximum is dated November 28, 1687.

COMET 1881 *b*.—It appears this comet was detected at Sydney as early as May 22, so that we may yet receive observations from the Australian observatories made nearly a week before the first of those made at Rio Janeiro. The orbit, founded upon post-perihelion places, which we published last week, gives the comet's place on May 22 at 10 p.m. at Sydney in right ascension 4h. 58·5m., declination 35° 33′ S., and at this time the comet was distant from the earth 0·772 of the earth's mean distance from the sun. M. Cruls' first position, deduced from the observations at Rio is as follows :—

M.T. at Rio.	R.A. h. m. s.	Decl. ° ′ ″
May 29·27980	5 2 3·8	−31 15 24·9

The comet was nearest to the earth about midnight on June 19, when its distance was 0·283.

The ephemeris subjoined is for Greenwich midnight:—

	R.A. h. m.	N.P.D. ° ′	Log. distance from the Earth.	Sun.
July 22	11 44·2	8 5·0	9·9290	0·0065
23	11 55·5	8 13·5		
24	12 5·9	8 22·7	9·9479	0·0173
25	12 15·5	8 32·4		
26	12 24·5	8 42·5	9·9657	0·0281
27	12 32·9	8 52·9		
28	12 40·7	9 3·4	9·9825	0·0388
29	12 48·0	9 13·9		
30	12 54·9	9 24·5	9·9982	0·0493
31	13 1·3	9 35·2		
August 1	13 7·4	9 45·9	0·0131	0·0597
2	13 13·2	9 56·4		
3	13 18·7	10 7·8	0·0271	0·0700
4	13 24·0	10 17·2		
5	13 29·2	10 27·4	0·0404	0·0800
6	13 34·3	10 37·4		

COMET 1881 *c*.—Telegrams from the Smithsonian Institution at Washington notify the discovery of a comet at the Observatory of Ann Arbor, by Mr. Schäberle, apparently on July 16; it was situate, according to the telegrams, nearly in the right ascension of Capella in 48° declination (or ? 38°).

NEAR APPROACH OF VENUS TO 107 TAURI.—Prof. Winnecke has circulated a note in which he suggests a method of determining the solar parallax from observations of this planet, when it approaches or occults a fixed star. We refer to the note at this time, only to draw attention to a close approach of the planet to 107 Tauri, a star of 6·5m. on the morning of July 24. According to a calculation by one of Prof. Winnecke's pupils the star will be occulted, but there appears to be some mistake here. Taking the star's place from the Greenwich Catalogue of 1864 and the Radcliffe Observations 1870-75, its apparent position will be R.A. 5h. 1m. 51·33s., Decl. +19° 42′ 15″·1, and at conjunction in R.A. July 23 at 20h. 26m.·2 G.M.T., the geocentric difference of declination (Venus-star) is 28″·7; this difference is reduced by the effect of parallax at Greenwich to 22″·9, and Wichmann's value of the semi-diameter of the planet being 10″·8, it appears neglecting tabular error of place, that at conjunction in right ascension, the south limb of Venus will be 12″ north of the star.

[Since the above was in type Dr. Gould's observations of the great comet at Cordoba have been received; they show that at the end of May the elements upon which our ephemeris is founded may give the comet's position with errors of + 1′·0 in R.A., and + 3′·8 in declination.]

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale des Sciences de Belgique, No. 3. —On the intensity of scintillation during auroræ boreales, by M. Montigny.—Observations on the anatomy of the adult African elephant, by MM. Plateau and Liénard.—On a general property of liquid sheets in motion, by M. Vander Mensburghe. —On the triangulation of the kingdom, by M. Adan.—On the magnetism of bodies in relation to their atomic weight, by M. Enera.—On the broadening of the lines of hydrogen (third communication), by M. Fiévez.

No. 4.—Liberty, and its mechanical effects, by M. Delbœuf. —Note on *Pretswichia rotundata*, J. Prestwich, discovered in the coal schist of Hornu, near Mons, by M. de Koninck.—On the transformation of methylchloracetol into acetone and thiacetone, by M. Spring.—On the blood of insects, by M. Fredericq.—Note on certain co-variants, by M. le Paige.—Researches on the reproductive apparatus of osseous fishes, by Mr. MacLeod.—On the stratigraphic position of remains of terrestrial mammalia discovered in Eocene strata of Belgium, by M. Rutot.

Archives des Sciences Physiques et Naturelles, June 15.—International Geological Congress at Bologna (1881); report of Swiss Committee on unification of nomenclature, by Renevier.—On an artificial reproduction of Gaylussite, by MM. Favre and Soret.—Study on palæontological and embryological development, by M. Agassiz.—Researches on alternating generations of Cynipides of oak, by M. Adler.—Observations on luminous plates, by M. Dufour.—Apparatus for Lissajous' curves, by the same.—The telephone and return currents of telegraph lines, by M. Cauderay.

Atti della R. Accademia dei Lincei, vol. v. fasc. 13.—Astronomical and physical observations on the axis of rotation and the topography of Mars, at the Royal Observatory of Brera, in Milan, with the Merz equatorial, by S. Schiaparelli.—Preliminary note on the volcanic ejection of tufa of Nocera and Samo, by S. Scacchi.—Researches on the variations of tone in the human blood-vessels, by Signori Rajardi and Mosso.—On observations of solar spots, faculæ and protuberances, at the Royal Observatory of the Roman College, during the first quarter of 1881, by V. Tacchini.—On the mean monthly and annual temperatures and the daily thermometric excursions deduced from observations at the observatory of the Roman College, by the same.—A supposed new red star, by the same.—Observations on small planets, by the same.—On the depolarising property of saline solutions, by S. Macaluso.—On the constitution of derivatives of santonine, by S. Cannizano.—On the action of bromine on naphthaline, by S. Magatti.—Attempt at synthesis of pyragallic acid, by the same.—On a new (3rd) homologue of pyrol contained in oil of Dippel, by Signori Ciamician and Dennstedt.—On cadaveric poisons, by S. Moriggia.—On the saccharifying ferment of wine, by S. Selmi.—Some theorems on geometry of *n* dimensions, by S. Veronese.—On the skeleton of Scelidoterian exhibited in the geological museum at Bologna, by S. Capellini.—Primordial fauna in Sardinia, by S. Meneghini.—On botanical taximony, by S. Carnel.—Ephemerides and statistics of the Tiber in 1880, by S. Betocchi.—Determination of the difference of longitude between Rome and Milan, by Signori Respighi and Celoria.—Absolute value of gravity at Rome, by S. Respighi.—On corrections in elliptical co-ordinates in the calculation of planetary perturbations, by S. de Gasparis.—Some artistic, literary, and geographical fragments of Leonardo da Vinci, by S. Govi.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, June 22.—R. Etheridge, F.R.S., president, in the chair.—Thomas Hart and David William Jones, Coronel, Chili, South America, were elected Fellows of the Society.—The following communications were read:—Description of a new species of coral from the Middle Lias of Oxfordshire, by R. F. Tomes, F.G.S. The species of coral described in this paper was referred by the author to the genus *Thamnastræa* and the sub-genus *Synastræa*, under the name of *Thamnastræa Walfordi*, in honour of its discoverer, Mr. E. A. Walford. The specimen was from the *Spinatus*-beds of the Marlstone, at Aston-le-Walls, Oxfordshire. Like *Thamnastræa Etheridgei*, previously described by the author (*Q. J. G. S.* xxxiv. p. 190) from the Middle Lias of Oxfordshire, this species presents the same sub-generic characters as *T. arachnoides* of the coral rag of Steeple Ashton; and the author remarks upon the fact that the only species known from the English Lias resemble corallian rather than Inferior-Oolite forms.—Note on the occurrence of the remains of a Cetacean in the Lower Oligocene strata of the Hampshire basin, by Prof. J. W. Judd, F.R.S., Sec.G.S. With a note by Prof. H. G. Seeley, F.R.S., F.G.S. The author referred to the rarity of remains of marine mammalia in the Lower Tertiaries of Britain, the only recorded species being *Zeuglodon Wanklyni*, Seeley, from the Barton clay. The single specimen in his possession was obtained at Roydon, about a mile and a half north of Brockenhurst, where the beds exposed in the brickyard consist of sandy clays crowded with marine fossils, and resting upon green freshwater clays, with abundance of *Unio Solandri* belonging to the Headon series. The author briefly referred to the question of the horizon of these deposits, which he regards as belonging to the same great marine series as the beds of Brockenhurst and Lyndhurst, which he holds to be Tongrian or Lower Oligocene. The Cetacean vertebra obtained by Prof. Judd was stated by Prof. Seeley to be a caudal vertebra, probably the eighth, but not later than the twelfth, of a species belonging, or closely related to the genus *Balænoptera*, and especially approaching *Balænoptera laticeps*, a species of the North Sea which appears to range to Japan. Prof. Seeley regarded it as representing a new species, which he named *Balænoptera Juddii*.—Description of a peat-bed interstratified with the boulder-drift at Oldham, by G. H. Hollingworth, F.G.S. The author described a deposit of peat interstratified with boulder-drift, exposed in a railway-cutting at Rhodes Bank, Oldham. The depth of the section was only 14 feet, and it showed:—

1. Soil	8 to 10 inches.
2. Boulder-clay, with beds and strings of peat	2 to 6 feet.
3. Main bed of peat, containing mosses, exogenous stems, and beetles	2 in. to 1 ft. 9 in. (average 15 in.).
4. Fine blue clay (floor)	2 inches to 1 foot.
5. Current-bedded coarse sand and fine gravel	4 inches to 2 feet.
6. Boulder-clay.	

The mosses in the peat are of northern type.

Silurian uniserial *Stomatoporæ* and *Ascodictya*, by G. R. Vine, communicated by Prof. P. Martin Duncan, F.R.S. For the genus *Stomatopora* the name *Alecto* has priority; but as that had previously been applied to a member of the class Echinodermata, the author preferred the later name. Species of the genus have also been described under the generic name *Aulopora*. The author has received from Mr. Maw more than two hundredweight of washed *débris* of Wenlock shale, about thirty pounds of which, from twelve localities, he has examined. It contains a moderate amount of Polyzoan remains, generally water-worn. The author described the following species:—*Stomatopora inflata* and *dissimilis*, *Ascodictyon stellatum* and *radians* (with a variety *siluriense*), and discussed the characters of the genera.—Note on the diamond-fields of South Africa, by E. J. Dunn, communicated by Prof. Ramsay, F.R.S. The passes or necks of decomposed gabbro, &c., at the Kimberley, Bultfontein, and other diamond-mines have now been excavated to a considerable depth, and have allowed excellent sections of the sedimentary beds through which they have broken to be examined. These are generally but little disturbed, and may be traced over an area of many square miles. Immediately beneath the surface are, generally, yellowish shales, with remains of small Saurians: and beneath these a mass, certainly more than a hundred feet thick, of black carbonaceous shales, with occasional thin bands of coal. It is found that the diamonds are more abundant and of better quality when the level of the black shales is reached. It seems, therefore, not improbable that the carbon requisite for the formation of diamonds was obtained from these shales. Some other points of minor interest were also noted in this paper.—On a new *Comatula* from the Kelloway Rock, by P. H. Carpenter, M.A., Assistant Master at Eton College, communicated by the President. The specimen, to which the author's attention was called by R. Etheridge, jun., is in the national collection; he proposes for it the name *Actinometra calloviensis*. The specimen is from the Kelloway rock, of Sutton Benger; the whole diameter is 15 mm.; diameter of centrodorsal ·6 mm. Three species of this genus are already known from the British Jurassic rocks; two are only known from their centrodorsals, which are each different from that of *A. calloviensis*. The third is *A. cheltonensis*, from the Inferior Oolite, known only by its radials and basals, which are different from those of the present specimen. To this *Antedon Picteti*, from the Valangian of the Continent, has some resemblance. It is, however, a true *Actinometra*, differing chiefly from existing forms in retaining its primary basals without their having undergone transformation into a rosette.—Descriptive catalogue of Ammonites from the Sherborne district, by Sydney S. Buckman. Communicated by Prof. J. Buckman, F.G.S., F.L.S., &c. In this paper the author gave a list of the Ammonites from the Inferior Oolite of the neighbourhood of Sherborne, in which he enumerated about forty-seven species, and stated that he had about fifty more which appear to be undescribed; fully one half have the mouth-termination perfectly preserved. The author indicated the zones into which the rocks furnishing these Ammonites could be divided, as shown at Oborne, near Sherborne, at Wyke Quarry, and at Bradford Abbas, and indicated the characteristic fossils of each; he also gave the principal synonyms of the species referred to, and discussed some of their characteristic peculiarities.—The next meeting of the Society will be held on November 2, 1881.

Entomological Society, July 6.—Mr. H. T. Stainton, F.R.S., president, in the chair.—One new Member and one Subscriber were elected.—Mr. W. L. Distant exhibited the sexes of *Morpho Adonis*.—Miss E. A. Ormerod exhibited some elm-leaves bleached by the attacks of a Coleopterous larva; and larvæ of a species of *Dolerus* and of *Charæas graminis*, feeding on grass.—Rev. E. A. Eaton exhibited drawings by Mr. A. T. Halleck of the nymphs of various *Ephemeridæ*.—The Secretary read the report of the Committee appointed at the last meeting to inquire into the history of an insect found feeding on the eggs of locusts in the Troad. It proved to be a dipterous insect apparently belonging to the *Bombyliidæ*; and specimens were exhibited by Sir S. S. Saunders.—The following papers were then read:—Mr. F. Moore, descriptions of new Asiatic diurnal *Lepidoptera*.—Mr. D. Sharp, on the species of the genus *Euchroma*.—Mr. J. W. Douglas, observations on the species of the homopterous genus *Orthezia*.—Mr. A. G. Butler, on the Lepidoptera of the Amazons collected by Dr. Trail during the years 1873-1875. Part iv. Geometrites.—Baron Osten-Sacken, note on the larva of Nycteribia.—Mr. W. F. Kirby, notes on new or interesting species of *Papilionidæ* and *Pieridæ* collected by Mr. Buckley in Ecuador.

EDINBURGH

Royal Society, June 6.—Sir Wyville Thomson, vice-president, in the chair.—Prof. H. Alleyne Nicolson, in a paper on the structure of the skeleton in *Tubipora*, and on the relations of the genus to *Syringopora*, argued that the similarity between the skeletons of these genera was only apparent, and that careful and minute microscopic study proved them to be built up in very different ways. In the former genus the skeleton is porous and made up of fused spicules. There are no tabulæ, and the axial tube, when present, seems to be simply the calcified wall of the body cavity, coming into contact with the external walls only at the nodes which mark the stages of growth. In the Syringopora again the skeleton is not porous, while there are true septa and funnel-shaped tabulæ which give rise to an axial tube.—Prof. Tait communicated a note by Mr. A. P. Laurie on an iodine battery, whose great merit is that it combines the simplicity of a single fluid cell with an electromotive force practically constant. Carbon and zinc plates dip into a solution of iodine in iodide of zinc, the iodine preventing polarisation. The zinc should not be amalgamated, and should be removed from the solution when the cell is not working. As tested by a quadrant electrometer, the electromotive force was very approximately one volt, and was hardly diminished, even after half an hour's short-circuiting.—In a note on chemical affinity and atomicity Mr. W. Durham brought forward certain objections to the generally-accepted theory of atomicity, arguing that there was no sufficient ground for assuming that one atomicity of a given element was saturated by one atomicity of another element in the compound, that this assumption led to the necessity of giving to certain elements different atomicities, and that it was more rational to suppose a given atomicity distributed among several of the like constituents of the compound.—Sir Wyville Thomson communicated a paper on the physical and biological conditions of the channel between Scotland and the Farö Islands. A series of soundings taken last summer had proved the existence of a narrow ridge running across this channel and flanked on both sides by deep water. Down to a depth of 260 fathoms (the depth of the ridge) the ocean water on both sides of this ridge was at much the same temperature, while at lower depths the water to the north-east was markedly colder than that to the south-west; thus at 450 fathoms the temperatures of these regions were respectively $30^{\circ}\cdot5$ F. and $47^{\circ}\cdot2$ F. The characteristic fauna of these regions showed a corresponding diversity, that of the north-east basin being similar to the Scandinavian fauna, and Arctic in character, that of the south-west being similar to the fauna found in the warmer waters all over the ocean bed. Many new forms were discovered in both of these regions.

June 20.—Prof. Maclagan, vice-president, in the chair.—Prof. Chrystal, in a note on Sturmian functions, gave a simple demonstration of a theorem of Joachimsthal, expressing a class of these functions as the successive minors of a symmetrical determinant.—Dr. Herdman communicated Part iv. of the Preliminary Report on the *Tunicata* of the *Challenger* Expedition.—Mr. D. B. Dott gave a short account of a series of experiments which he had made on comenic acid and its salts, which he regarded as establishing its dibasic character.—Dr. Macfarlane read a paper on Morgan's systems of consanguinity and affinity, which he had examined with the help of his analysis of relationships. The paper consisted of two parts, the first being a criticism of the tables of data, the second of an explanation of the so-called classificatory methods. The classification proceeds according to difference of generation, and is merely one mode in which the relationship ideas may be expressed in words. Mr. Morgan's hypothesis of a consanguine and of a Panaluan family are contradicted by the data which they are introduced to explain.—Prof. Tait communicated a note on a proposition in the theory of numbers.

PARIS

Academy of Sciences, July 11.—M. Wurtz in the chair.—The following papers were read :—On the formation of the tails of comets, by M. Faye. A reply to M. Flammarion. The tail is not rigidly connected with the nucleus. The repellent force is proportional to the surfaces, is weakened by interposition of a screen, is not propagated instantaneously, and varies in inverse ratio of the square of the distance.—Theory of plane flexion of solids and consequences relating to construction of astronomical telescopes, and to their regulation, getting rid of deviations of the optic axis due to flexion, by M. Villarceau.—On the velocity of propagation of explosive phenomena in gases, by M. Berthelot. The experiments were with mixtures of hydrogen and oxygen and of carbonic oxide and oxygen (2 vols. to 1). These were placed in a long iron tube (open or close, fixed in various positions, &c.), and were inflamed with an electric spark ; the passage of the wave was measured by an electric method. The velocity was in general about 2500 m. per second. Explosive phenomena are more complex than a simple motion of translation or even than the propagation of a sound wave.—Reply to M. de Lesseps on M. Roudaire's project, by M. Cosson.—On the borings made in strata to be traversed by the Panama Canal, by M. de Lesseps. The strata of large section will offer sufficient consistency for formation of talus, while not presenting the resistance of hard rock.—Study in experimental thermodynamics on steam-engines, by M. Ledieu.—Photography of the spectrum of comet *b* 1881, by Dr. Huggins. M. Berthelot thought the spectra rendered probable the electric origin of the proper light of comets.—Influence of phosphoric acid on phenomena of vegetation, by M. de Gasparin.—Remarks on the accidents caused by use of sulphide of carbon in treatment of vines in the South of France, by M. Cornu.—Shocks of an earthquake at Gabes on June 13 were reported.—On the comet of 1881 observed at the Imperial Observatory of Rio de Janeiro, by M. Cruls.—Observations on the same comet at Algiers Observatory, by M. Trépied.—Further observations by M. Wolf and by M. Thollon (See page 261).—Attempt at explanation of the tails of comets, by M. Picart. A comet, consisting of gaseous matter and luminous ether, appears, at a distance from the sun, in spheroidal form (the luminous ether being then invisible). But on nearing the sun the luminous ether of that star repels the luminous ether of the comet; hence the tail.—On the polarisation of the light of comets, by M. Prazmowski. The comet is shown to reflect solar light abundantly —New method of determining certain constants of the sextant, by M. Gruey.—On Kleinian groups, by M. Poincaré.—On a general means of determining the relations between constants contained in a particular solution, &c. (continued), by M. Dillner.—On the three centrifugal axes, by M. Brassinne.—On the absolute measurement of currents by electrolysis, by M. Mascart. By careful experiment he finds the intensity of the current capable of producing in one second the electrolysis of 1 equiv. of a substance expressed in milligrammes is equal to 96·01 w., or say 96 webers.—On the reality of kinematic equivalence in undulatory optics, by M. Crouillebois. M. Cornu made some remarks.—On the chlorides of iron, by M. Sabatier.—On the oxychlorides of strontium and of barium, by M. André.—Experimental researches on decomposition of picrate of potash ; analysis of products, by MM. Sarrau and Vieille.—On decipium and samarium, by M. Delafontaine. He reserves the name *decipium* for the radical of the earth having an equivalent of about 130 ; *samarium* for the other metal (in samarskite) whose absorption spectrum was described by M. Lecoq. (The equivalent of samarine is probably under 117.)—Action of peroxide of lead on alkaline iodides, by M. Ditte.—On ethers of morphine considered as phenol, by M. Grimaux.—Researches on tertiary monamines ; III. Action of triethylamine on ethers with hydracids of secondary and tertiary alcohols, by M. Reboul.—On cyanised camphor, by M. Haller.—On the composition of hydrosulphite of soda and of hydrosulphurous acid, by M. Bernthsen.—Two facts relating to decilene (oil of turpentine), by M. Maumené.—On *viscose*, or the gummy substance of viscous fermentation, by M. Béchamp.—Determination of urea with the aid of titrated hypobromite of soda, by M. Quinquaud.—Researches on animal heat, by M. d'Arsonval. By direct calorimetry he proves the great absorption of heat by the egg in incubation during the first day (a fact otherwise proved by M. Moitessier). Oxygen is abundantly absorbed and carbonic acid emitted. During sleep or complete rest, animals absorb much oxygen and make little heat, the emission of carbonic acid varying slightly. The author hardly ever found agreement between the heat measured directly and the heat calculated from respiratory combustions ; this is because organic combustion is of the order of fermentation. The chemical method gives the sum ; direct calorimetry the difference. The two methods should be combined.—Action of maté on gases of the blood, by MM. d'Arsonval and Couty.—Absorbed by the stomach or the veins, maté diminishes the carbonic acid and the oxygen of arterial and venous blood enormously (sometimes a third or a half of the normal quantity) —On the seat of cortical epilepsy and of hallucinations, by M. Pasternatzky. Cortical epilepsy is really what the name implies. The hallucinations he produced in a dog with absinthe he attributes to excitation of the sensitive sub-cortical centres by that substance.—On the alterations of the cutaneous nerves in pellagra, by M. Dejerine.—On venous circulation by influence, by M. Ozanam. Among the various causes of progression of blood in the veins is an important influence exercised on each vein by the artery associated with it. The vein-walls experience a rebound from the arterial movements.—On the structure of the oothecæ of Mantes, and on the hatching and first moulting of the larvæ, by M. Brongniart.—Chemical researches on the product of secretion of the ink-bag of Cephalopoda, by M. Girod.—On the synchronism of the marine carboniferous fauna of Ardoisière (Allier), and the anthraciferous fauna of Roannais and Beaujolais, by M. Julien.—M. Laurey noted, about the comet, that the sunlight illuminated only the left part, leaving the right dark—a true cometary phase.

VIENNA

Imperial Academy of Sciences, June 23.—L. T. Fitzinger in the chair.—L. T. Fitzinger, examination of some species which were till now incorporated with the species *Ursus arctos*.—F. Steindachner, contributions to the knowledge of African fishes (contains a description of a new species of *Sargus* from the Galapagos Islands).—Joh. Mayer, on the trajectory of the 1880 *b* comet.—Max. Margules, on the motions of viscous liquids and on the figures of motion.—F. Ströhmer, on the occurrence of ellagic acid in pine-bark.—Ernst Schneider, a sealed packet (experiment on the construction of high-power telescopes).—MM. Neumayr and Emil Holub, on the fossils at the Uitenhage formation in South Africa.—M. Neumayr, studies on fossil Echinodermata.—V. v. Lang, on the coefficient of refraction of concentrated solutions of cyanine.—L. Haitinger, on the occurrence of malic and citric acid in *Chelidonium maius*.—Dr. T. Puluj, a sealed packet (without inscription).

CONTENTS